PB82-190240

Draft Environmental Impact Statement City of Los Angeles Wastewater Facilities Plan. Addenda I and II

Los Angeles City Dept. of Public Works, CA

Prepared for

Environmental Protection Agency
San Francisco, CA

Sep 77

U.S. Department of Commerce
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The study is a review of the Draft Environmental Impact Statement/Environmental Impact Report for the City of Los Angeles Wastewater Treatment Facilities Plan. The EIS/EIR summary and full report present the environmental, economic and social effects of wastewater facility planning decisions which will affect over 3.4 million persons living in the City of Los Angeles and contract cities. The main purpose of this document is to publicize the long range environmental and social effects of wastewater facility alternatives so that citizens and governmental agencies can comment and express their concerns and preferences.

KEYWORDS: *Sludge disposal, *Sewage disposal, *Environmental impact statements-draft, *Ocean waste disposal, *Los Angeles(California).

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

ENVIRONMENTAL IMPACT STATEMENT CITY OF LOS ANGELES WASTEWATER FACILITIES PLAN

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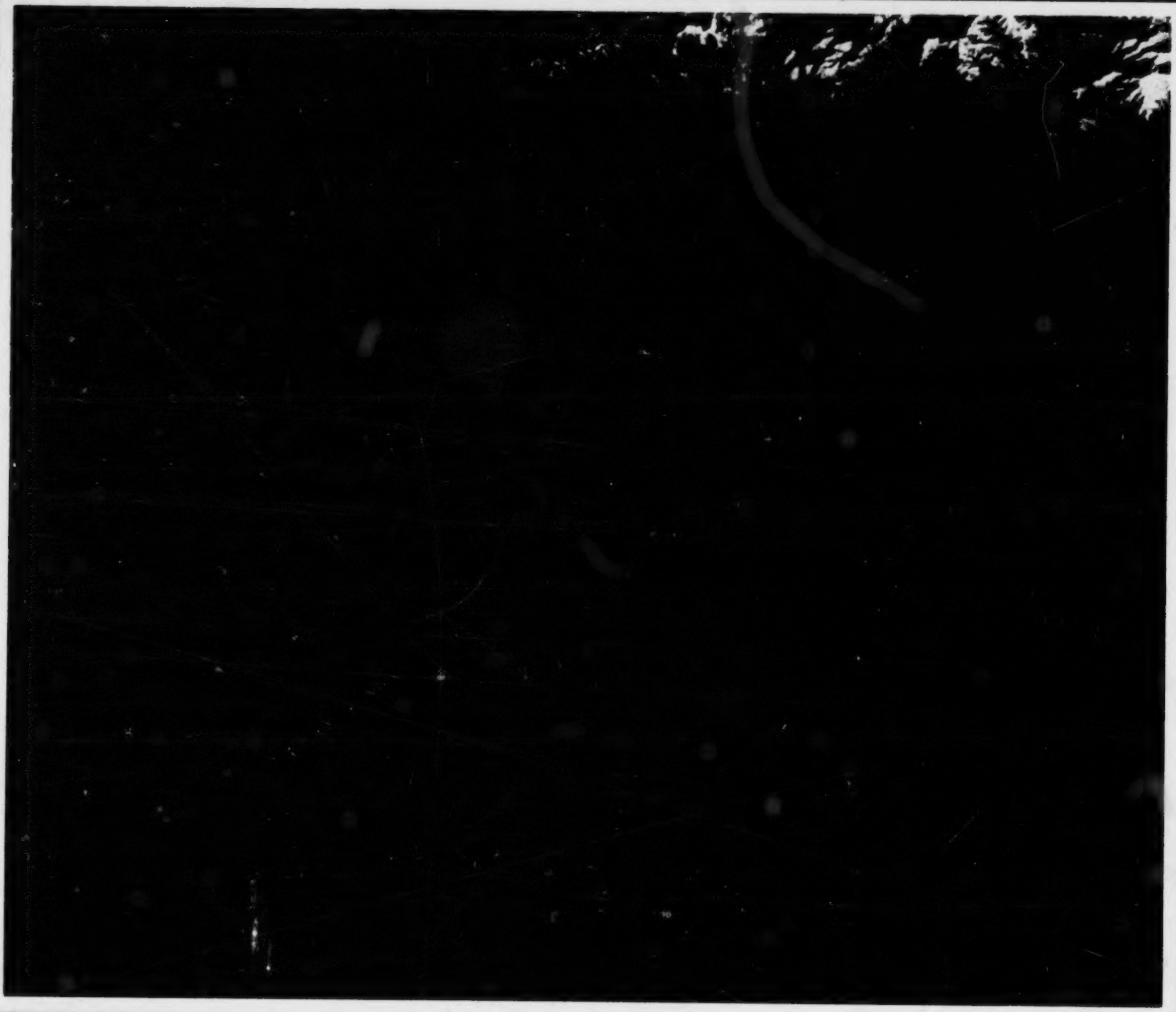

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Addenda I and II

September 1977

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ENVIRONMENTAL IMPACT STATEMENT CITY OF LOS ANGELES WASTEWATER FACILITIES PLAN

September 1977

Addenda I and II

i.a

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
100 CALIFORNIA STREET
SAN FRANCISCO, CALIFORNIA 94111

SEP 01 1977

To All Interested Agencies, Public Groups, and Concerned Individuals:

This study is a review of

We submit for your review and comment the Draft Environmental Impact Statement/Environmental Impact Report for the City of Los Angeles Wastewater Treatment Facilities Plan. This statement has been prepared in compliance with the National Environmental Policy Act of 1969 (P.L. 91-190), and implementing regulations promulgated by the Council on Environmental Quality and the Environmental Protection Agency. It has also been prepared in compliance with the California Environmental Quality Act and its implementing regulations.

The EIS/EIR summary and full report present the environmental, economic and social effects of wastewater facility planning decisions which will affect over 3.4 million persons living in the City of Los Angeles and contract cities, and involve capital costs in excess of 300 million dollars over the next five years.

The main purpose of this document is to publicize the long range environmental and social effects of wastewater facility alternatives so that citizens and governmental agencies can comment and express their concerns and preferences. Public comments are expected to play a key role in (1) selection of long-range alternatives for the service area, including size and location of collection and treatment facilities, and (2) implementation of measures needed to reduce adverse environmental effects.

The Environmental Protection Agency, Region IX and the City of Los Angeles, Bureau of Engineering will hold hearings on the Draft EIS, approximately 30 days following the distribution of the EIS. The exact place and date will be announced. All interested parties are invited to express their views at the hearings. Persons wishing to make comments may submit them in writing and/or appear at the hearings. Oral statements will be considered, but, for the record, all important testimony should be submitted to:

Environmental Protection Agency, Region IX
Attn: Fred Krieger, W-1
100 California Street
San Francisco CA 94111

Enough copies of the written material should be provided so that other interested parties at the hearing may receive a copy. Oral statements should summarize extensive written material since it is necessary for all interested parties to be heard. After the public hearings the Draft EIS/EIR will be revised in light of the comments to form the Final EIS/EIR.

If you do not comment at the public hearings, you may send written comments to EPA at the address given above within thirty days following the hearings.

The following documents constitute the EIS:

Mini-Summary
General Summary
Main text (3 volumes)
Addendum 1. Reclamation Options
Addendum 2. Environmental Analysis of Reclamation
Addendum 3. Interim Sludge Processing and Disposal System
Appendices

Copies of these documents can be obtained by written or by telephone requests at the address given above or at:

City of Los Angeles, Bureau of Engineering
City Hall East-Room 650
200 North Main Street
Los Angeles CA 90012 Attn: Fred Hoeptner
(213)485-3089

Additionally the Draft EIS and supplemental information may be reviewed at the above addresses or at the public libraries within the service area of the City of Los Angeles.

Please bring this notice to the attention of all persons who would be interested in this matter.

Sincerely,

Sheila M. Prindiville

for Paul De Falco, Jr.
Regional Administrator

Addendum I
reclamation options

i-d

ADDENDUM I
CITY OF LOS ANGELES
ENVIRONMENTAL IMPACT STATEMENT
ON THE WASTEWATER FACILITIES PLAN

RECLAMATION OPTIONS

THIS DOCUMENT IS THE SAME AS
APPENDIX F TO THE FACILITIES PLAN

PREPARED BY:
CITY OF LOS ANGELES DEPARTMENT OF WATER AND POWER
WATER SYSTEM–SANITARY ENGINEERING DIVISION

i.F

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PREFACE

This report was initiated and prepared by the Department of Water and Power (Department or DWP) to incorporate considerations for water reclamation planning in the City of Los Angeles Wastewater Facilities Planning process. The intent has been to coordinate the separate planning goals of wastewater treatment and disposal with those of water reclamation so as to provide maximum flexibility to achieve these respective goals in a cost-effective manner. An additional purpose of this report is to integrate discussion of all potential reclaimed water markets that might be served by the City of Los Angeles into one planning document so that specific projects could be proposed for further development and implementation. The information presented is based on specific Department experience and knowledge in the area of water reclamation.

The Department undertook preparation of this report because it is the City agency having the primary authority under the City Charter to reclaim and sell wastewater to customers both within and outside the City of Los Angeles, as confirmed in a legal opinion by the City Attorney's office, dated March 6, 1972.

During the preparation of this report, it became apparent that two major constraints exist that could preclude incorporation of the desired flexibility for water reclamation in the design of wastewater treatment facilities. These constraints are:

1. Design of Secondary Treatment Facilities at Hyperion.

   A decision was made on February 13, 1975 by the management of the Environmental Protection Agency, State Water Resources Control Board (SWRCB), and the City of Los Angeles Department of Public Works to proceed with the Step 2 - Design of the Hyperion Treatment Plant, prior to completion of the Step I - Facilities Planning. The design of this facility was initiated early in an attempt to meet the 1979 NPDES permit requirement for full secondary treatment and sludge disposal. Time constraints do not allow for major changes in design as have been proposed by DWP staff as this would delay the overall compliance schedule.

2. Secondary Treatment at Hyperion Using the UNOX Process.

   The SWRCB, by Order No. WQC 77-3, dated February 17, 1977, approved removal of the existing 100 mgd (constant flow) coarse bubble secondary treatment system at Hyperion and the installation of a 307 mgd (mean annual flow) high-rate pure oxygen

(UNOX) secondary system at the same location. DWP staff has opposed secondary treatment with UNOX because the estimated resulting effluent quality is inadequate for water reclamation without significant additional treatment.

It has been the opinion of DWP staff that these constraints can be offset while still meeting the dual planning objectives of disposal and reclamation if certain options are undertaken which provide the additional flexibility required for water reclamation.

Limited land at the Hyperion Treatment Plant and questions regarding the effluent quality produced by the UNOX process resulted in the investigation of upstream sites for water reclamation. This investigation concluded with a recommendation for construction of an upstream wastewater treatment plant with coarse bubble secondary treatment, filtration, and the flexibility to provide nitrification such that the effluent water quality would be controlled for reclaimed water use rather than waste disposal. We have called this proposed plant the La Cienega Water Reclamation Plant (LCWRP). This proposed 75 mgd plant could be constructed in place of equivalent capacity at the Hyperion Treatment Plant, leaving Hyperion with a nominal installed capacity of 232 mgd. It was further proposed that Hyperion use fine bubble aeration for secondary treatment with flexibility for nitrification of part of the effluent for reuse, rather than the 307 mgd pure oxygen system for disposal as proposed in Alternative B-4 of the Facilities Plan.

Recent discussions with State Board staff have made it apparent that the constraints (No. 1 and 2 presented above) are fixed by PL 92-500 compliance requirements, and the options developed by DWP are essentially precluded from consideration at this time. Although this report discusses reclamation options which include the LCWRP, the results of this report are currently limited in application to those projects which are consistent with the selected wastewater facilities plan alternative (B-4). Unfortunately, this leaves several water quality, flexibility, and land availability questions unresolved. Future implementation of water reclamation will require further consideration of major modifications or relocation of wastewater treatment facilities (including the LCWRP option) in addition to advanced treatment and distribution to the reclaimed water users. It is anticipated that the cost of making these modifications as a separate project would be higher than the cost of providing the needed flexibility at this time.

SUMMARY

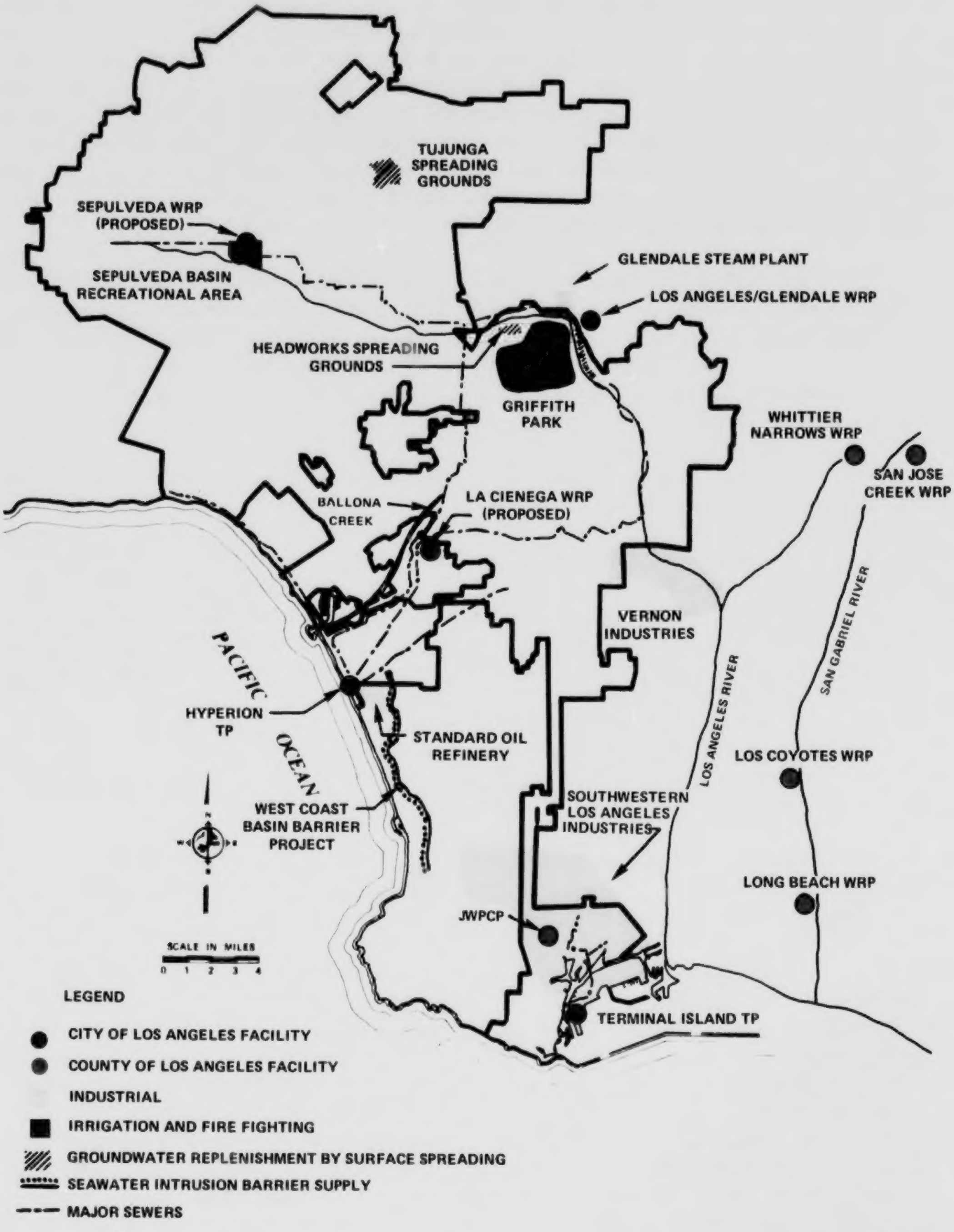
The purpose of this report is to compare the costs associated with water reclamation as it relates to the two most viable wastewater management plan alternatives under consideration by the City's Department of Public Works. These alternative plans are identified as Alternatives "B" (inland/coastal treatment) and "E" (maximum reclamation). The major difference between the two plans is that better quality effluent for reclamation is predicted to be produced with one Alternative "E" than with ~~Alternative~~ the second "B" due to the construction of an additional treatment plant upstream from the Hyperion Treatment Plant. Both alternatives would produce an effluent complying with State and Federal discharge requirements.

Under Alternative "B", the Hyperion Treatment Plant would be designed to produce effluent quality suitable for ocean disposal. Pure oxygen would be used for secondary treatment aeration to treat an average annual flow rate of 307 mgd. Sludge removed from the upstream treatment plants (Sepulveda and Los Angeles–Glendale Water Reclamation Plants) would be returned to the outfall sewer systems for processing and disposal at the Hyperion Treatment Plant.

Alternative "E", which consists of several subalternatives, essentially modifies the treatment capacity and method of secondary treatment at the Hyperion Treatment Plant as proposed under Alternative "B". It proposes a new inland treatment plant which would reduce the cost of water reclamation by producing a secondary effluent better suited for reclamation. The capacity of the Hyperion Treatment Plant would be reduced to 232 mgd using fine bubble aeration for secondary treatment. The new inland plant, (La Cienega Water Reclamation Plant) would be designed to produce 75 mgd of filtered secondary effluent using the standard rate coarse bubble process. Sludge from the Sepulveda and La Cienega Water Reclamation Plants would not be returned to the outfall but would be conveyed in a separate force main system directly to the digesters at the Hyperion Treatment Plant to avoid increasing the dissolved solids load in the raw wastewater going to Hyperion. Land acquisition for the La Cienega site is considered to be difficult as the City does not currently own the required land.

The differences in wastewater treatment between Alternatives "B" and "E" result in different advanced treatment requirements and reclaimed water distribution systems and, thus, different costs for water reclamation as presented in this report.

Four specific uses for reclaimed water are identified. They are: groundwater replenishment by spreading, seawater intrusion barrier supply, industrial water supply, and irrigation and recreation uses. The location of these uses are shown in Figure SR.1. Potential reclaimed water markets are identified for a total theoretical use of up to 193 mgd (216,000 acre-feet/year). However, this maximum developable market includes several prospective markets whose use would probably be too small to be served economically. Therefore, the total reclaimed water market demand used in this study was reduced to 177 mgd (198,000 acre-feet/year). This amount is nearly one-third of the average total water demand of the City of Los Angeles (540 mgd); however, approximately two-thirds of this potential market is outside the City and so would not reduce demands on the City's water system by that full amount.


TUJUNGA SPREADING GROUNDS
SEPULVEDA WRP (PROPOSED)
SEPULVEDA BASIN RECREATIONAL AREA
GLENDALE STEAM PLANT
LOS ANGELES/GLENDALE WRP
HEADWORKS SPREADING GROUNDS
GRIFFITH PARK
WHITTIER NARROWS WRP
SAN JOSE CREEK WRP
BALLONA CREEK
LA CIENEGA WRP (PROPOSED)
VERNON INDUSTRIES
SAN GABRIEL RIVER
LOS ANGELES RIVER
PACIFIC OCEAN
HYPERION TP
STANDARD OIL REFINERY
WEST COAST BASIN BARRIER PROJECT
LOS COYOTES WRP
SOUTHWESTERN LOS ANGELES INDUSTRIES
LONG BEACH WRP
JWPCP
TERMINAL ISLAND TP
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SCALE IN MILES
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LEGEND
● CITY OF LOS ANGELES FACILITY
● COUNTY OF LOS ANGELES FACILITY
INDUSTRIAL
■ IRRIGATION AND FIRE FIGHTING
▨ GROUNDWATER REPLENISHMENT BY SURFACE SPREADING
SEAWATER INTRUSION BARRIER SUPPLY
MAJOR SEWERS
198P-423

Figure SR.1. Potential reclaimed water use in the Los Angeles area.

TABLE 1 SUMMARY OF POTENTIAL RECLAIMED WATER USES

SERVICE AREA	RECLAIMED WATER USE	AGENCY SERVING DOMESTIC WATER	MGD (YEAR)	MAF 1980–2000	WATER QUALITY CONCERNS
Headworks and Tujunga Spreading Grounds	Groundwater Replenishment[1]	City of Los Angeles	45[2] (1985)	0.76	Health aspects of organics and virus.
Griffith Park	Irrigation	City of Los Angeles	5 (1980)	0.11	Beneficial and adverse effects of long-term use on plant growth and soil productivity.
Sepulveda Basin Recreational Area	Irrigation	City of Los Angeles	9 (1980)	0.20	Beneficial and adverse effects of long-term use on plant growth and soil productivity.
South Los Angeles Industries	Industrial	City of Los Angeles Dominguez Water Corp. City of Torrance	52 (1985)	0.87	Effect of high nutrient and TDS level on facilities and operation.
Standard Oil Refinery	Industrial	City of El Segundo	8 (1985)	0.13	Effect of high nutrient and TDS level on facilities and operation.
Vernon Industries	Industrial	City of Vernon	20 (1985)	0.34	Effect of high nutrient and TDS level on facilities and operation.
Glendale Steam Plant	Industrial	City of Glendale	3 (1980)	0.07	Control of phosphate and suspended solids.
West Coast Basin Barrier Project	Seawater Intrusion Barrier	Central and West Basin Water Replenishment District	35 (1990)	0.39	Health aspects of organics and virus and injection water quality criteria.

[1] The quantity counted as having been returned to use is that which has been extracted from the basin after recharge and delivery to a customer. Thus, facilities for this use include those to extract and deliver the groundwater.

[2] The amount shown is the total proposed to be spread for groundwater replenishment; of that total, only 30 mgd average annual use is expected during the period 1985–2000. Thus, about 200,000 acre-feet of water would be stored during the period.

A summary of the potential reclaimed water markets is presented in Table 1. The water quality concerns are indicated as well as the agencies presently serving domestic water to these users, both within and outside the City of Los Angeles. Additional discussion of each use including the specific issues related to the use and the status of activities related to development of the use are contained in the body of the report.

The monetary cost, energy, and land requirements to provide reclaimed water to the potential markets are developed. In the analysis, it was found that the costs and requirements for certain reclaimed water markets are sensitive to the choice between Wastewater Management Plan Alternative "B" and Alternative "E". By sensitive, we mean the need for dollars, land, and energy to develop water reclamation is greater for one alternative than for the other. This sensitivity is limited to those potential reclaimed water markets which could be served from the Hyperion Treatment Plant since that is the only facility where variations between Alternatives "B" and "E" occur. Reuse of Sepulveda and Los Angeles–Glendale Water Reclamation Plant effluents is not affected by changes in these alternatives. The magnitude of the sensitivity of the cost of reclamation to Alternatives "B" and "E" is also dependent upon the quantity of reclaimed water use to be developed as is shown in Table 2. Results of this study indicate that for any given level of reclamation, implementation of Alternative "B" would result in increased monetary costs and requirements for energy and land over Alternative E. In addition, these differences increase as the level of reclamation increases. However, the sensitivity analysis did not include the costs and requirements associated with sewage treatment as these costs would not likely be included in the development of a reclaimed water revenue program. For an overall cost analysis, the reader is referred to Chapter 8 of the Facilities Plan.

An analysis of the potential revenue requirements for water reclamation is presented to show the financial feasibility of reclamation. The result of this analysis is that water reclamation does not appear to be financially feasible in the Los Angeles area unless some significant outside sources of funding are available to subsidize reclamation. A possible solution to this problem is to include water reclamation as an element of the State Water Project whereby reclaimed water could be developed in lieu of using imported water from the State Water Project in the Los Angeles area. This would result in an extension of the usable supply of the State Water Project as additional local water sources would be developed instead of developing new sources for importation. Additional funding may be required from the State Water Project contractors which in turn could be directed to fund local water reclamation. No attempt was made at this time to determine whether water reclamation is a cost-effective alternative source of supply for the State Water Project.

TABLE 2

SENSITIVITY OF RECLAIMED WATER USE REQUIREMENTS TO WASTEWATER MANAGEMENT PLAN ALTERNATIVES B AND E

SYSTEM NO.	RECLAIMED WATER			NET INCREASED REQUIREMENT TO PROVIDE RECLAIMED WATER FOR USE FOR THE PERIOD 1980 THRU 2000 ALTERNATIVE B OVER E[1]				
	Total Use[2] for the Period 1980–2000 (Million Acre-Feet)	Use Tested for Sensitivity	Incremental Flow (mgd)	Average Monetary Cost (Millions 1975 Dollars)	Energy (Billions Kwh)	Energy (Millions bbls. Oil)	Land Deficiency[4] (Acres)	Average Revenue Deficit[3] (Millions 1975 Dollars)
1	1.75	Minimum Industrial	30	14	0.7	1.2	0	22
3	2.11	Moderate Industrial	52	26	1.3	2.2	5	41
5	2.44	Maximum Industrial	72	52	1.8	3.0	10 – 11	72
6	2.83	Maximum Industrial plus Seawater Intrusion Barrier	107	62	1.8	3.0	18	74

1. Data taken from Tables 4.6, 4.7, 4.8, 4.15, 4.16, 4.19, and 5.9 and Figure 4.1.

2. The total system use for the four systems presented includes the following uses plus the use tested for sensitivity:

Sepulveda Basin Recreational Area	9 mgd	Headworks/Tujunga Spreading Grounds	45 mgd
Griffith Park	5 mgd	Standard Oil Refinery	8 mgd
Glendale Steam Plant	3 mgd		

3. This revenue deficit represents the minimum revenues required to support development of the total reclaimed water use identified which is expected to reduce quantity of demand on the State Water Project.

4. Assumed 27 acres previously acquired for the La Cienega Water Reclamation Plant under Alternative E.

RECOMMENDATION

Based on the data presented in this report, the costs and energy requirements for water reclamation are more favorable under Wastewater Management Plan Alternative E (maximum reclamation) than for Alternative B (upstream/coastal treatment) for all potential levels of reclamation analyzed. However, because this analysis did not include the costs and energy requirements of wastewater treatment for disposal, no specific recommendation can be made in this report as to the best alternative. The results do indicate that consideration of an additional upstream water reclamation plant such as the La Cienega Water Reclamation Plant should be retained in the Facilities Plan for implementation at such time as a water reclamation program is undertaken.

Several areas of this report require additional development to firm up the data presented. Marketing studies are recommended to confirm the data presented on potential reclaimed water demand and water quality requirements of the various users. More refined analyses of wastewater treatment, advanced treatment and distribution costs are required to assess the cost-effectiveness of water reclamation. Additional work is also needed in the area of financial feasibility to determine the appropriate penalty costs for each agency involved in the reclamation program, the actual amount of outside funding required to implement water reclamation, and the feasibility of including water reclamation as an element of the State Water Project.

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CHAPTER 1

INTRODUCTION

The City of Los Angeles is preparing to upgrade the City's wastewater system to meet current State and Federal standards for effluent discharge to receiving waters. Such upgrading will result in a greater degree of treatment for much of the City's wastewater, thus improving the potential opportunity for reclaiming and reusing the wastewater.

Two documents are being prepared to aid the City in making a decision on the wastewater facilities needed to meet the State and Federal standards. These documents are: 1) a Wastewater Facilities Plan (Plan), and 2) an Environmental Impact Report/Statement on that Wastewater Facilities Plan (EIR/EIS). Guidelines and agreements that must be followed in the preparation of these documents call for inclusion of information on the water reclamation potential of each wastewater management plan alternative.

Grant funding was authorized by the State Water Resources Control Board for the City of Los Angeles Department of Water and Power to work with the Department of Public Works in the preparation of a report on water reclamation to supplement both the "Plan" being prepared by the Department of Public Works (DPW), and the "EIR/EIS" being prepared by the DPW consultant. This reclamation report has been developed to be attached to the "Plan" as an appendix, and to provide basic information for preparation of an environmental analysis of water reclamation in the "EIR/EIS".

1.1 PURPOSE AND SCOPE

The purpose of this water reclamation report is to provide information with which to make decisions on wastewater management alternatives such that balanced consideration is given to both the control of water pollution by wastewater treatment and disposal, and flexibility for water reclamation and reuse. An additional purpose of this report is to integrate information on all potential reclaimed water markets that could be served by the City of Los Angeles in one planning document so that specific reclamation projects can be further developed and implemented.

The studies which produced the information identified in this report were comprehensive. They included a review of proposed wastewater treatment processes, potential markets for reclaimed water, and existing water supply uses and availability. This development was considered essential, since the information produced may be used to justify a substantial investment in wastewater treatment facilities to provide flexibility for water reclamation.

The scope of this investigation was limited to the development and analysis of costs directly associated with water reclamation. This was done because the costs of water reclamation (which include wastewater treatment plant modifications, advanced treatment, and reclaimed water distribution system) are incremental to the costs of wastewater disposal. As such, the costs of wastewater treatment for disposal would not be included in the development of a reclaimed water revenue program. The reader is referred to the Facilities Plan for the appropriate wastewater treatment costs.

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The scope of investigation was also limited to analyzing existing information. At this time, *no* potential reclaimed water markets have been confirmed; however, an analysis was conducted which compared the effect of various levels of water reuse (from low potential to high potential) on the two wastewater management plan alternatives. In addition, information is presented on prospects for, and restrictions on the development of each reclaimed water use.

This report is organized to present the reader with the results of the analysis of various levels of reuse of the City's wastewater. In Chapter 2, the two wastewater management plan alternatives ("B" – upstream and coastal, and "E" – maximum reclamation) are described – particularly the key aspects which relate to water reclamation. In Chapter 3, the potential reclaimed water markets and service areas are identified, showing the quality and quantity requirements, the schedule of use, and key factors related to development of each use. In Chapter 4, the estimates of monetary costs, energy requirements, and land requirements basic to Wastewater Management Plan Alternatives "B" and "E" are presented for the treatment and distribution of reclaimed water to potential markets. Finally, in Chapter 5, a financial analysis of the use of reclaimed water is presented to show a potential distribution of the monetary costs of providing reclaimed water between the water user, various water purveyors, and the reclaimed water producer, with the State Water Project as a source of additional funding – again based on Wastewater Management Plan Alternatives "B" and "E".

1.2 BACKGROUND

The Department of Water and Power has conducted a number of recent studies in water reclamation. These efforts in planning for reclamation demonstrate the Department's interest in reclamation and background for preparing this report. These studies, which represent an investment of more than $1,000,000 during the past ten years, are discussed below.

In 1968, the DWP completed a report entitled *Water Reclamation for the City of Los Angeles* in cooperation with the Department of Public Works and Department of Recreation and Parks. Much of the information in this current report is based on that 1968 report.

From 1968 through 1970, the DWP conducted bench and pilot plant studies to evaluate the feasibility of serving reclaimed water as a source of supply to the West Coast Basin Barrier Project. Further development of that project from 1970 through 1974 included a proposal to conduct a 3 mgd demonstration project to make a in-depth investigation of the technical aspects of the project. In 1974, the project was postponed due to funding limitations. The following reports related to that project have been prepared by DWP:

A Report on the Los Angeles Water Recycling Project, Playa del Rey – 1972

Report on the Hyperion Pilot Plant No. 1 – 1972

Ozonation: Information Relating to its Potential Use as a Treatment Process for the Los Angeles Water Recycling Project, Playa del Rey – 1974

Second Project Report on the Los Angeles Water Recycling Project, Playa del Rey – 1976

Since 1967, the DWP has conducted two surveys to determine the potential industrial markets for reclaimed water in the Carson–Torrance and Harbor areas. The results of these surveys are included in this report.

An evaluation has been made of the opportunities to reuse effluent from the Sepulveda Water Reclamation Plant for groundwater recharge. The Headworks Test Basin Study was developed and the spreading basins operated from December 1974 through January 1976 to determine spreading ground capacity for infiltration and contaminant removal using secondary effluent. The cost to reuse the water as well as the impacts of this use on domestic water quality have been developed. More development and analysis is needed before a groundwater recharge program can be implemented. However, the results of the preliminary evaluation are included in this report. The following reports related to this project have been prepared by DWP:

Predicted Water Qualities Resulting from Various Wastewater Treatments and Infiltration into the San Fernando Valley Groundwater Basin – 1972

Headworks Test Basin Proposal – 1972

Use of Reclaimed Water from the Sepulveda Wastewater Reclamation Plant – 1972

The Effect of Sepulveda and Los Angeles–Glendale Water Reclamation Plants on Domestic Water Quality – 1975

Headworks Test Basin Study Annual Monitoring Report for 1975 – 1976

The main thrust of the work done by DWP staff during the current period of wastewater facilities planning has been directed toward promoting flexibility for water reclamation where this can be done without imposing any significant financial burden on the cost of wastewater disposal. It is our hope that, by this approach, future reclamation efforts will be able to provide for facilities that are more economical and relatively free from constraints.

CHAPTER 2

WASTEWATER SYSTEM AND ALTERNATIVE MANAGEMENT PLANS

An understanding of the wastewater management system is necessary before reclaimed water and reclamation potential can be analyzed. This chapter describes the wastewater system of the City of Los Angeles and the current wastewater plan alternatives being considered to upgrade that system to meet the requirements of PL 92–500.

The wastewater management plan alternatives being considered by the City are important to the discussion of reclamation potential in this report since they are the basis from which the results are presented. A careful review of the details which make up each alternative is necessary before the impacts of these alternatives on water reclamation potential can be seen. The advanced wastewater treatment which must be provided for equal water reclamation potential varies with each wastewater management plan alternative, and thus, the cost of reclamation varies with each alternative.

The goals of the City's plans for wastewater system improvements for wastewater management require 1) that adequately sized wastewater collection and treatment facilities be installed for hydraulic relief for flows envisioned through the year 2000, and 2) at least secondary treatment be provided to all wastewater discharging to a stream or to the ocean. To accomplish these requirements, two major improvements are needed: 1) hydraulic relief must be provided for wastewater flows from the San Fernando Valley and 2) secondary treatment must be provided for approximately 295 mgd (annual average) of City of Los Angeles wastewater flows (in addition to the current 100 mgd of secondary treatment).

Achievement of these goals will provide an increased opportunity to reuse the effluents of the wastewater treatment plants, and thus, water reclamation is considered an element in the selection of treatment alternatives.

The Los Angeles City Wastewater Facilities Plan Report includes a full description of the present wastewater system and the improvement alternatives being considered. This chapter contains only a summary of the key information from that report to allow this report on water reclamation to be complete as a separate document.

2.1 WASTEWATER QUALITY IN THE EXISTING SYSTEM

The wastewater system of the City of Los Angeles includes a major sewerage network plus treatment and disposal facilities. Current annual average flows (1975) in the system range to over 360 million gallons per day (mgd). By the year 2000, the flow should exceed 400 mgd. Treatment currently takes place at three locations: Hyperion Treatment Plant (primary and partial secondary), LA/Glendale Water Reclamation Plant (primary, secondary and filtration), and Terminal Island Treatment Plant (primary and secondary). The current outfall capacities and projected wastewater flows of the major system (Hyperion) are presented in Figure 2.1. The Terminal Island system in the Harbor area is not presented since reclamation is not an issue at this time for this plant.

figure 2.1

PROJECTED INTERCEPTOR DAILY AVERAGE FLOWS OF THE HYPERION SYSTEM

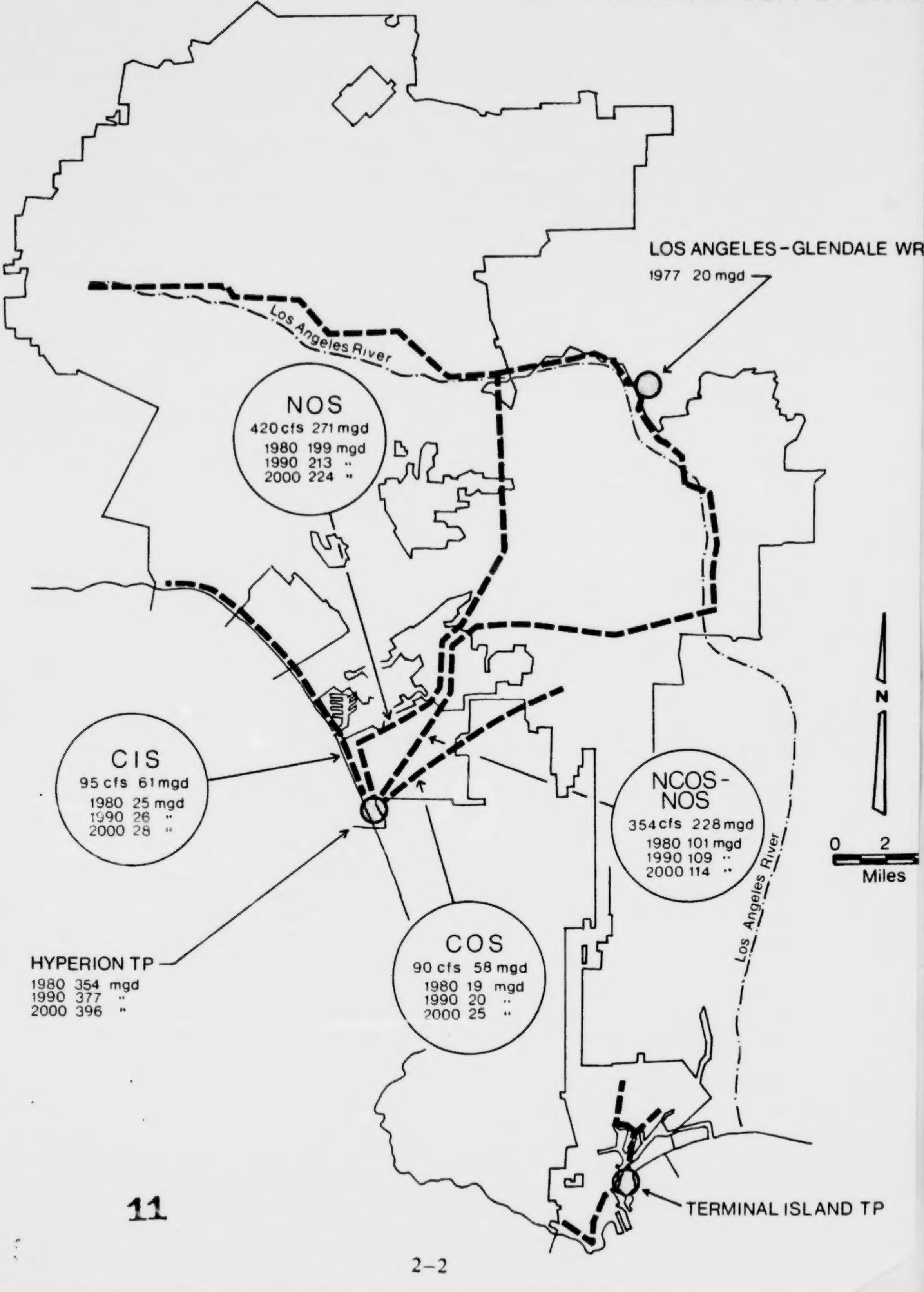
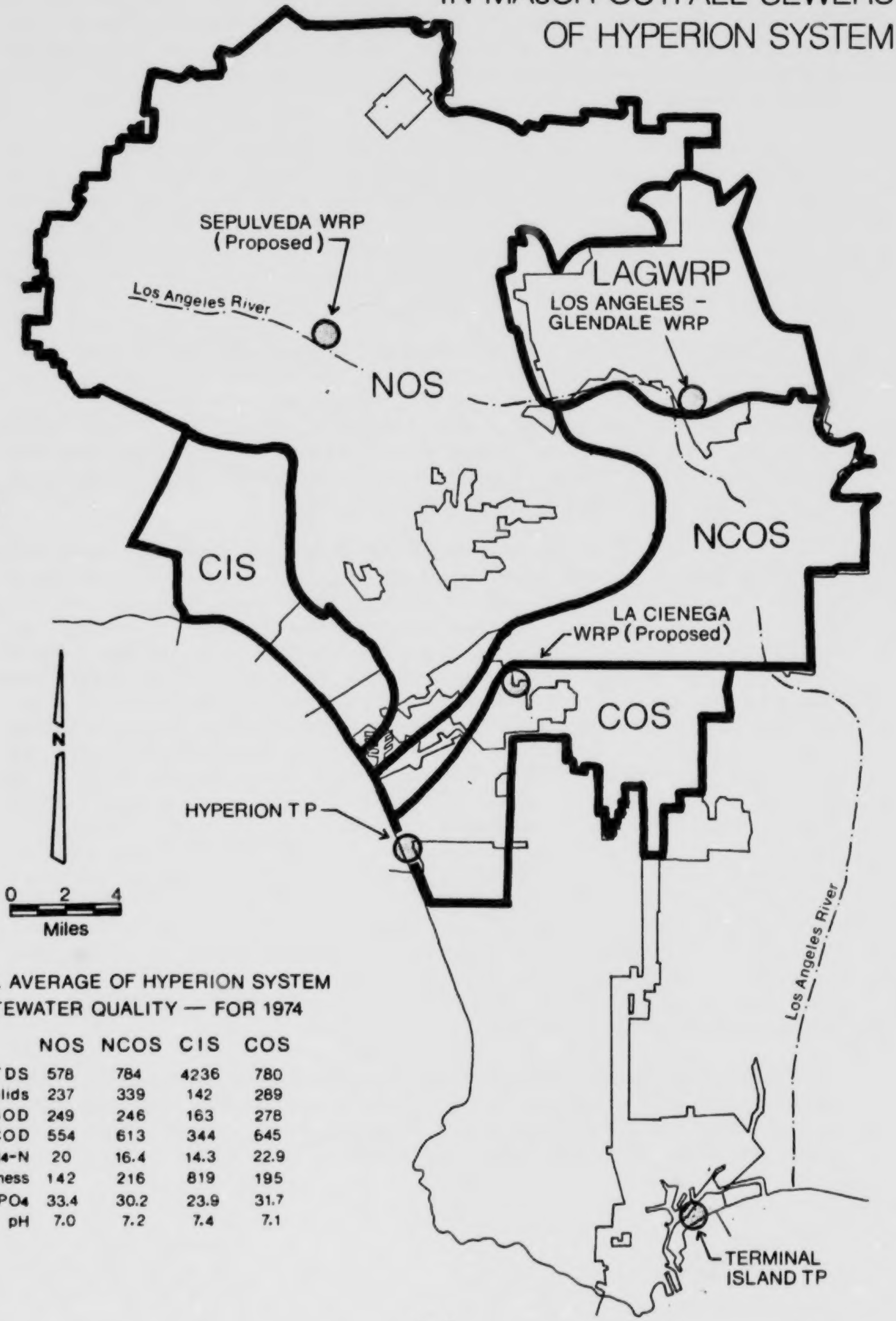

LOS ANGELES-GLENDALE WR
1977 20 mgd
Los Angeles River
NOS
420 cfs 271 mgd
1980 199 mgd
1990 213 "
2000 224 "
CIS
95 cfs 61 mgd
1980 25 mgd
1990 26 "
2000 28 "
NCOS-NOS
354 cfs 228 mgd
1980 101 mgd
1990 109 "
2000 114 "
N
0 2
Miles
Los Angeles River
HYPERION TP
1980 354 mgd
1990 377 "
2000 396 "
COS
90 cfs 58 mgd
1980 19 mgd
1990 20 "
2000 25 "
TERMINAL ISLAND TP

figure 2.2

TRIBUTARY AREA AND WASTEWATER QUALITY IN MAJOR OUTFALL SEWERS OF HYPERION SYSTEM


SEPULVEDA WRP
(Proposed)
Los Angeles River
NOS
LAGWRP
LOS ANGELES -
GLENDALE WRP
CIS
NCOS
LA CIENEGA
WRP (Proposed)
COS
N
0 2 4
Miles
HYPERION T P
Los Angeles River
TERMINAL
ISLAND TP

ANNUAL AVERAGE OF HYPERION SYSTEM WASTEWATER QUALITY — FOR 1974

	NOS	NCOS	CIS	COS
TDS	578	784	4236	780
Suspended Solids	237	339	142	289
BOD	249	246	163	278
COD	554	613	344	645
NH_4-N	20	16.4	14.3	22.9
Total Hardness	142	216	819	195
PO_4	33.4	30.2	23.9	31.7
pH	7.0	7.2	7.4	7.1

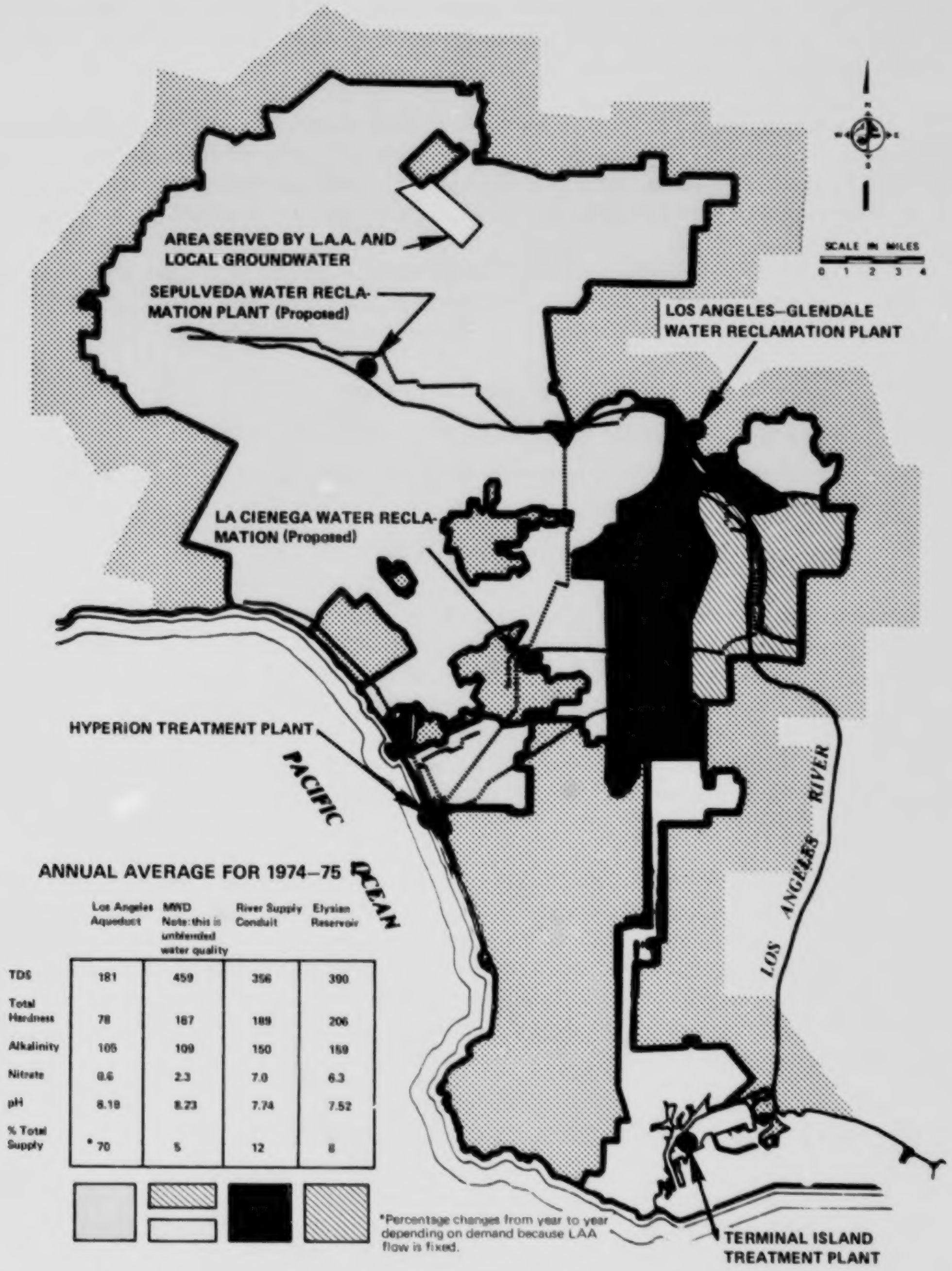
The Terminal Island Treatment Plant was screened out as a source of reclaimable wastewater principally because the raw wastewater TDS concentration is in excess of 2000 mg/l. Typically, industrial and irrigation water quality criteria calls for maximum TDS in the range of 700 to 1000 mg/l. To meet this TDS criteria would require including a demineralization process in the treatment which would boost the cost of treated wastewater to an extremely uncompetitive price by adding unit costs in the range of $250 per acre-foot.

The quality of the wastewater flows in the Hyperion system is of primary importance in determining the potential quality of the reclaimed water. The Hyperion system is made up of four tributary areas which are served by the four major outfall sewers as shown in Figure 2.2. These outfall sewers tend to segregate the City of Los Angeles into areas having discrete wastewater qualities. In addition, a separate tributary area serves the Los Angeles–Glendale Water Reclamation Plant with waste sludge being discharged into the NCOS–NOS.

The wastewater quality in Los Angeles is determined primarily by the water supply of the areas served by the four outfall sewers, the type of water use (domestic, commercial or industrial), and the amount and quality of any sewer infiltration or inflow. Figure 2.3 identifies the quality of water supplied in various areas tributary to the wastewater system. Water system changes which could occur throughout the wastewater planning period (1975–2000) are not expected to substantially change the quality of water provided to the areas identified in Figure 2.3.

Approximately 70% of the water used in the Hyperion Tributary area comes from the Owens Valley via the Los Angeles Aqueduct (LAA). The proportionately large service area of this water is shown in Figure 2.3. The next major source, which represents 12% of the supply to this area, is local well water distributed through a system called the River Supply Conduit (RSC). This water is a blend of LAA water and San Fernando Valley groundwater. The ratio of the blend and the resulting water quality varies throughout the year. RSC water is delivered in the Central City area which has domestic and light industrial uses. RSC water also flows to Elysian Reservoir where it is blended with Pollock Well water (located east side of LA River, south of Glendale) supplying 8% of the City. The addition of higher TDS Pollock Well water lowers the quality of the water served in the Elysian system (see Figure 2.3). The third major source is imported water purchased from the Metropolitan Water District which accounts for about 5% of the total supply. This water is a blend of water from the State Water Project and the Colorado River Aqueduct. The Central and East Los Angeles areas are supplied with a blend of water from the MWD and either RSC or Elysian Reservoir, depending on the service area, as shown on Figure 2.3. The water quality served in these areas depends upon seasonal demands, since higher demand in the summer results in the purchase of more high TDS MWD water. The water quality table on Figure 2.3 lists the water sources which make up the various water blends. The remaining 5% of the supply is made up of local groundwater sources.

The remaining factors which affect the quality of the raw wastewater are: 1) the waste contribution to the system through domestic, industrial, and commercial uses of many types, and 2) infiltration in the collection system. Of these, the major mineral degradation occurs from contributions by automatic water softeners discharging to


AREA SERVED BY L.A.A. AND LOCAL GROUNDWATER
SEPULVEDA WATER RECLAMATION PLANT (Proposed)
LOS ANGELES–GLENDALE WATER RECLAMATION PLANT
LA CIENEGA WATER RECLAMATION (Proposed)
HYPERION TREATMENT PLANT
PACIFIC OCEAN
LOS ANGELES RIVER
TERMINAL ISLAND TREATMENT PLANT
SCALE IN MILES
0 1 2 3 4
198P-425

ANNUAL AVERAGE FOR 1974–75

	Los Angeles Aqueduct	MWD Note: this is unblended water quality	River Supply Conduit	Elysian Reservoir
TDS	181	459	356	390
Total Hardness	78	167	189	206
Alkalinity	105	109	150	159
Nitrate	0.6	2.3	7.0	6.3
pH	8.18	8.23	7.74	7.52
% Total Supply	* 70	5	12	8
	▢	▨ ▢	■	▨

*Percentage changes from year to year depending on demand because LAA flow is fixed.

Figure 2.3. Distribution and water quality of waters served to Los Angeles.

sewers, uncontrolled industrial and commercial discharges, and seawater infiltration. Figure 2.2 clearly shows the effects of these contributions: excessive TDS in the Coastal Interceptor Sewer (CIS) due to seawater infiltration in the Venice area and a general increase in TDS, hardness, and organic constituents in all other sewers. If the saline flow in the CIS is segregated from other (better) wastewater at Hyperion, there would be a greater potential for reclamation at Hyperion.

Identification of water quality in major outfall sewers is a key to developing water reclamation proposals. Segregation of waste flows and redistribution of water supplies within tributary areas can be important considerations in maximizing the cost-effectiveness of water reclamation. Additional studies are required in this area.

The type of wastewater treatment provided also has a significant effect on water quality available for reclamation. The existing and proposed City of Los Angeles wastewater treatment plants are shown on Figure 2.4 and listed below:

Sepulveda Water Reclamation Plant (Proposed)
Los Angeles–Glendale Water Reclamation Plant (Existing)
La Cienega Water Reclamation Plant (Proposed)
Hyperion Treatment Plant (Existing)
Terminal Island Treatment Plant (Existing)

The quality of treated wastewater produced by each of the inland plants is relatively similar for each wastewater management plan alternative, while the flow at the two ocean discharge plants is of slightly poorer quality due to different waste discharge requirements. This estimated quality is presented in Table 2.1 with the type of secondary process used and the type of discharge requirement. The disposition of waste sludge from the upstream facilities is also important to water quality, as this sludge contains high amounts of heavy metals and similar inorganic contaminants which can degrade the wastewater at Hyperion.

The Hyperion Treatment Plant, designed for ocean discharge, has very limited land for treatment, and thus, a high rate process is required to meet secondary treatment requirements. The use of a high rate treatment process is not expected to provide an effluent quality as good as that produced by a standard rate process, and so the potential for reclamation is reduced. This difference in quality is thought to occur because the high rate process does not provide the level of biological uptake of organic and inorganic constituents found in a standard rate system.

2.2 WASTEWATER MANAGEMENT PLAN ALTERNATIVES

The City of Los Angeles Wastewater Facilities Plan Report considers eight distinct wastewater management plan alternatives. This report describes the potential for water reclamation afforded by two of the eight alternatives. These two are:

Alternative B – Upgrading via Upstream and Coastal Treatment
Alternative E – Maximum Reclamation

LOCATION OF EXISTING AND PROPOSED WASTEWATER TREATMENT FACILITIES

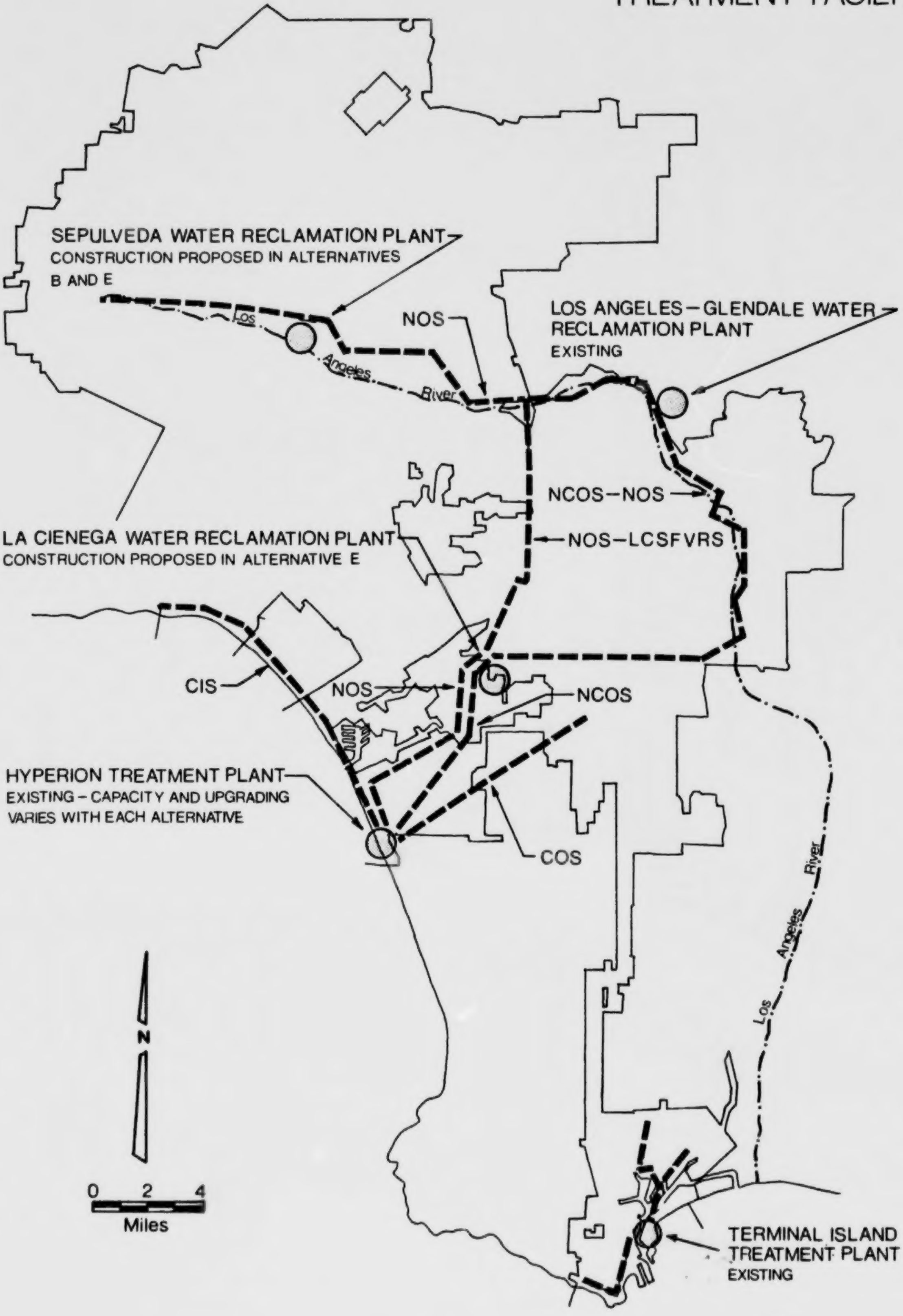

SEPULVEDA WATER RECLAMATION PLANT
CONSTRUCTION PROPOSED IN ALTERNATIVES B AND E
Los Angeles River
NOS
LOS ANGELES – GLENDALE WATER RECLAMATION PLANT
EXISTING
NCOS – NOS
LA CIENEGA WATER RECLAMATION PLANT
CONSTRUCTION PROPOSED IN ALTERNATIVE E
NOS – LCSFVRS
CIS
NOS
NCOS
HYPERION TREATMENT PLANT
EXISTING – CAPACITY AND UPGRADING VARIES WITH EACH ALTERNATIVE
COS
Los Angeles River
N
0
2
4
Miles
TERMINAL ISLAND TREATMENT PLANT
EXISTING

TABLE 2.1

WASTEWATER TREATMENT PLANT ESTIMATED EFFLUENT QUALITY

WATER QUALITY PARAMETER	WASTEWATER TREATMENT PLANT AND SECONDARY TREATMENT SCHEME				
	Hyperion Treatment Plant[3] High Rate[1]	La Cienega WRP Standard Rate[2] with Filtration	Sepulveda WRP Standard Rate[2] with Filtration	Los Angeles Glendale WRP Standard Rate[2] with Filtration	Terminal Island Treatment Plant Standard Rate[2]
TDS	750	650	500	500	2200
Suspended Solids	25 – 30	<5	<5	<5	30
BOD	25 – 30	5	5	5	30
COD	70	25	25	25	70
NH_4–N	12	10	10	10	12
TKN	25	12	12	12	15
(NO_2+NO_3) –N	0	0	0	0	0
PO_4	25	10	10	10	10
pH	6.7	7.4	7.4	7.4	7.4
Total Hardness – $CaCO_3$	180	130	95	95	––
Alkalinity – $CaCO_3$	175	165	120	120	––
Type of Discharge Requirement Applied	Ocean	Stream	Stream	Stream	Ocean

1. Using pure oxygen
2. Using coarse bubble diffusers
3. Assumed quality with Coastal Interceptor Sewer influent segregated

The reason only two alternatives were considered in this report is that all other alternatives were eliminated in the preliminary cost-effectiveness analysis of the Facilities Plan Report (Chapter VIII), with only Alternatives B and E being recommended for detailed analysis.

The Wastewater Management Plan Alternatives propose various combinations of wastewater treatment facilities to satisfy the goals of the Facilities Plan. The location of the existing and proposed wastewater treatment facilities relative to the City's outfall sewer system is shown in Figure 2.4. These wastewater treatment facilities can impact reclamation through (1) the quality of the plant effluent, (2) the quantity of effluent available, and (3) the location of the facility relative to the potential reclaimed water uses.

The general distinction between Alternatives B and E is that a new upstream wastewater treatment plant with a high reclamation potential (La Cienega Water Reclamation Plant) is included in Alternative E and *not* in Alternative B. Thus, the wastewater flow at the Hyperion Treatment Plant varies with the alternatives, having an average annual flow of 307 mgd for Alternative B and 232 mgd for Alternative E (with La Cienega Water Reclamation Plant at 75 mgd). Additional description of Alternatives B and E follows:

Alternative B – Upgrading via Upstream and Coastal Treatment

Two of Alternative B subalternatives are under serious consideration in the Facilities Plan. Alternative B–3 proposes to supply relief of the NOS–LCSFVRS tunnel flows by construction and expansion of Sepulveda Water Reclamation Plant (SWRP). Alternative B–4 is further divided into five sub-alternatives, A through E. The Facilities Plan selection process determined that Alternative B–4C is the most viable, but for the purposes of this report, it will be referred to as Alternative B–4. Alternative B–4 proposes expansions at both the Sepulveda WRP and the Los Angeles–Glendale WRP (LAGWRP). Both alternatives would have Hyperion modernized and expanded to 307 mgd with high rate secondary treatment using pure oxygen aeration. In addition, waste sludge from the upstream plants is returned to the outfall sewer system for treatment at Hyperion. Table 2.2 summarizes the construction and expansion schedule of Alternatives B–3 and B–4. Alternative B–4 was selected as representative of the "B" category for discussion of Alternative B's impact on reclamation.

Alternative B's concept of upgrading the wastewater management system via upstream and coastal treatment facilities results in considerable flexibility for reclamation activities at the upstream facilities, but limited flexibility for reclamation at Hyperion. SWRP and LAGWRP effluents would be available for potential development of reclamation and reuse in the San Fernando Valley. The 307 mgd of secondary effluent from Hyperion is sufficient in quantity to satisfy all potential reclaimed water uses that might be developed in the central and southern Los Angeles areas; however, the poorer effluent quality than that provided by the upstream treatment facilities and limited available land for additional treatment may constrain such development.

There is open land adjacent to the Sepulveda facility that could site an advanced treatment facility. This, however, is not true for Hyperion. It is estimated that nearly all of the open land on the Hyperion property would be consumed in constructing the

TABLE 2.2

WASTEWATER MANAGEMENT PLAN ALTERNATIVE B
SCHEDULE OF TREATMENT PLANT CAPACITY AND PROCESS

WASTEWATER MANAGEMENT PLAN ALTERNATIVE	WASTEWATER TREATMENT PLANT AND SECONDARY TREATMENT SCHEME			
	Hyperion Treatment Plant High Rate	La Cienega WRP Standard Rate	Los Angeles–Glendale WRP Standard Rate	Sepulveda WRP Standard Rate
B–3	307 mgd (1980)	No	Existing – 20 mgd	Initial – 40 mgd (1977)
				Expansion – 40 mgd (1980)
				15 mgd (1993)
B–4	307 mgd (1980)	No	Existing – 20 mgd	Initial – 40 mgd (1977)
			Expansion – 10 mgd (1988)	Expansion – 30 mgd (1980)
				15 mgd (1993)

TABLE 2.3

WASTEWATER MANAGEMENT PLAN ALTERNATIVE E
SCHEDULE OF TREATMENT PLANT CAPACITY AND PROCESS

WASTEWATER MANAGEMENT PLAN ALTERNATIVE	WASTEWATER TREATMENT PLANT AND SECONDARY TREATMENT SCHEME			
	Hyperion Treatment Plant High Rate	La Cienega WRP Standard Rate	Los Angeles–Glendale WRP Standard Rate	Sepulveda WRP Standard Rate
E–1	232 mgd* (1980)	75 mgd (1985)	Existing – 20 mgd	Initial – 40 mgd (1977)
			Expansion – 10 mgd (1988)	Expansion – 30 mgd (1980)
				15 mgd (1993)
E–2	307 mgd (1980)	75 mgd (1985)	Expansion – 10 mgd (1988)	Initial – 40 mgd (1977)
	232 mgd** (1985)		10 mgd (1988)	Expansion – 30 mgd (1980)
				15 mgd (1993)

*Advanced primary installed for temporary achievement of standards – to be removed when La Cienega WRP operational.

**Treatment plant capacity converted when La Cienega WRP operational.

proposed 307 mgd secondary treatment expansion. Thus, suitable open land would have to be found in the vicinity of Hyperion to allow reclamation and reuse of Hyperion's effluent. This could be a significant problem since no such land is readily available.

Alternative E – Maximum Reclamation

Wastewater Management Plan Alternative E attempts to maximize the changes for reclamation by reducing the extra cost to supply reclaimed water above that basic cost required for wastewater disposal. Alternative E proposes construction of the Sepulveda Water Reclamation Plant as in Alternative B to relieve the flow in the NOS–LCSFVRS tunnel. This inland plant would serve as the major source of reclaimed water for the San Fernando Valley in conjunction with the LAGWRP. Alternative E is divided into subalternatives E–1 and E–2. Both alternatives include construction of a new wastewater treatment plant upstream from the Hyperion Treatment Plant, the La Cienega Water Reclamation Plant, at 75 mgd capacity. The only distinction between Alternatives E–1 and E–2 is the way modifications to the Hyperion Treatment Plant are made. In all "E" subalternatives, waste sludge from SWRP and LCWRP is conveyed directly to Hyperion for sludge treatment via a separate force main sewer system, thus reducing the chances for water quality degradation at Hyperion and La Cienega Water Reclamation Plants.

Alternative E–1 calls for initial construction of facilities for 232 mgd of secondary capacity (high rate, fine bubble) to upgrade the Hyperion Treatment Plant. During the initial period until the La Cienega WRP is operational, advanced primary facilities would be installed at Hyperion to allow operation of the secondary system at 307 mgd to achieve discharge standards.

Alternative E–2 calls for initial construction of the full 307 mgd of secondary capacity (high rate, pure oxygen), to upgrade the Hyperion Treatment Plant with later conversion to 232 mgd (high rate, fine bubble) when the La Cienega WRP is operational. Thus, in Alternative E–2, 75 mgd of additional secondary facilities (compared to Alternative E–1) are constructed, but these could be converted to provide advanced treatment (nitrification). Table 2.3 summarizes the construction and expansion schedule of Alternatives E–1 and E–2.

The La Cienega Water Reclamation Plant (LCWRP) is proposed to be constructed adjacent to the northerly area of Culver City where the NOS and the NCOS are located in close proximity. This facility could make reclaimed water available for industrial water uses that may be developed in the central and southern Los Angeles areas. It would produce a filtered secondary effluent of a quality assumed to require only the addition of the biological nitrification process to be acceptable for many industrial reclaimed water markets. If the LCWRP is found to be viable through further research, additional treatment requirements for water reclamation would be limited to nitrification and the land requirements at the Hyperion Treatment Plant for water reclamation would be substantially reduced.

The City does not presently own land at the proposed LCWRP site for such a plant, nor does it have any prospects for such ownership. Site acquisition is estimated to require five to ten years of litigation, if it can be acquired at all. With a few years to resolve justification of the LCWRP, this would result in a delayed start-up date of 1983 at the earliest, and possibly much later if the anticipated land acquisition problems develop. Due to the delay in construction of the La Cienega Water Reclamation Plant, Alternative E–1 would include temporary installation of 75 mgd of advanced primary treatment facilities at the Hyperion Treatment Plant. This treatment may satisfy effluent discharge requirements for the interim period until the La Cienega Water Reclamation Plant is operational and can provide relief treatment for that amount of water. The concept of advanced primary treatment would require a pilot study, special regulatory agency consideration, and a possible NPDES permit change.

CHAPTER 3

RECLAIMED WATER USES AND SERVICE AREAS

The purpose of this chapter is to identify and evaluate potential reclaimed water markets that could be developed by the City of Los Angeles and served with effluent from the City's wastewater facilities. Specific *service areas* are identified which can be supplied by a single distribution system. By definition, a reclaimed water *service area* must be a fairly localized area having potential for developing a significant reclaimed water use. All uses should have similar water quality requirements and they should be capable of being served by a single distribution system. Otherwise, distribution costs become prohibitive.

The following procedure was used in proposing the reclaimed water service areas. First, major categories of reclaimed water use suited to the Los Angeles area were identified. These include: groundwater replenishment, seawater intrusion barrier supply, industrial water supply, and irrigation and recreation water supply. Locations where such uses might occur, their potential amounts of use, and estimates of their water quality requirements were determined. Next, those uses which did not constitute relatively large volume uses were screened out as they would not likely be cost-effective by themselves. Serving such uses would only be practical if served by a larger distribution system. The remaining localized use areas were further investigated to develop more specific information on potential flows, water quality requirements and the like. This was accomplished through surveys, telephone conversations, and report reviewing. This information combined with wastewater treatment plant locations was used in defining the specific service areas to be considered in this report.

The results of this development of service areas are used in Chapter 4 to determine treatment requirements, distribution systems and costs for providing reclaimed water to each of these service areas.

3.1 POTENTIAL RECLAIMED WATER USES

There are four uses for reclaimed water that show potential for future development in or near the City of Los Angeles. These uses are: 1) groundwater replenishment by spreading, 2) seawater intrusion barrier supply, 3) industrial water supply, and 4) irrigation and recreation water supply. Each of these uses exist in areas which could be supplied by water reclaimed by the City of Los Angeles as shown in Figure 3.1. If all these uses were developed to the maximum extent considered in this study, the estimated demand would total 193 mgd as summarized in Table 3.1. Most of the uses presented in this chapter represent only estimated reclaimed water markets and much additional refinement and negotiation will be required to establish the existence and long-term demands of such markets. However, for purposes of this comparison of alternatives, reasonable water reclamation plans can be proposed for each wastewater management plan alternative based on those potential uses and the alternatives can be rated as to their value for water reclamation.

Groundwater Replenishment by Spreading

The use of reclaimed water for groundwater replenishment by spreading has the potential for conserving large quantities of water in the Los Angeles area if health

TABLE 3.1

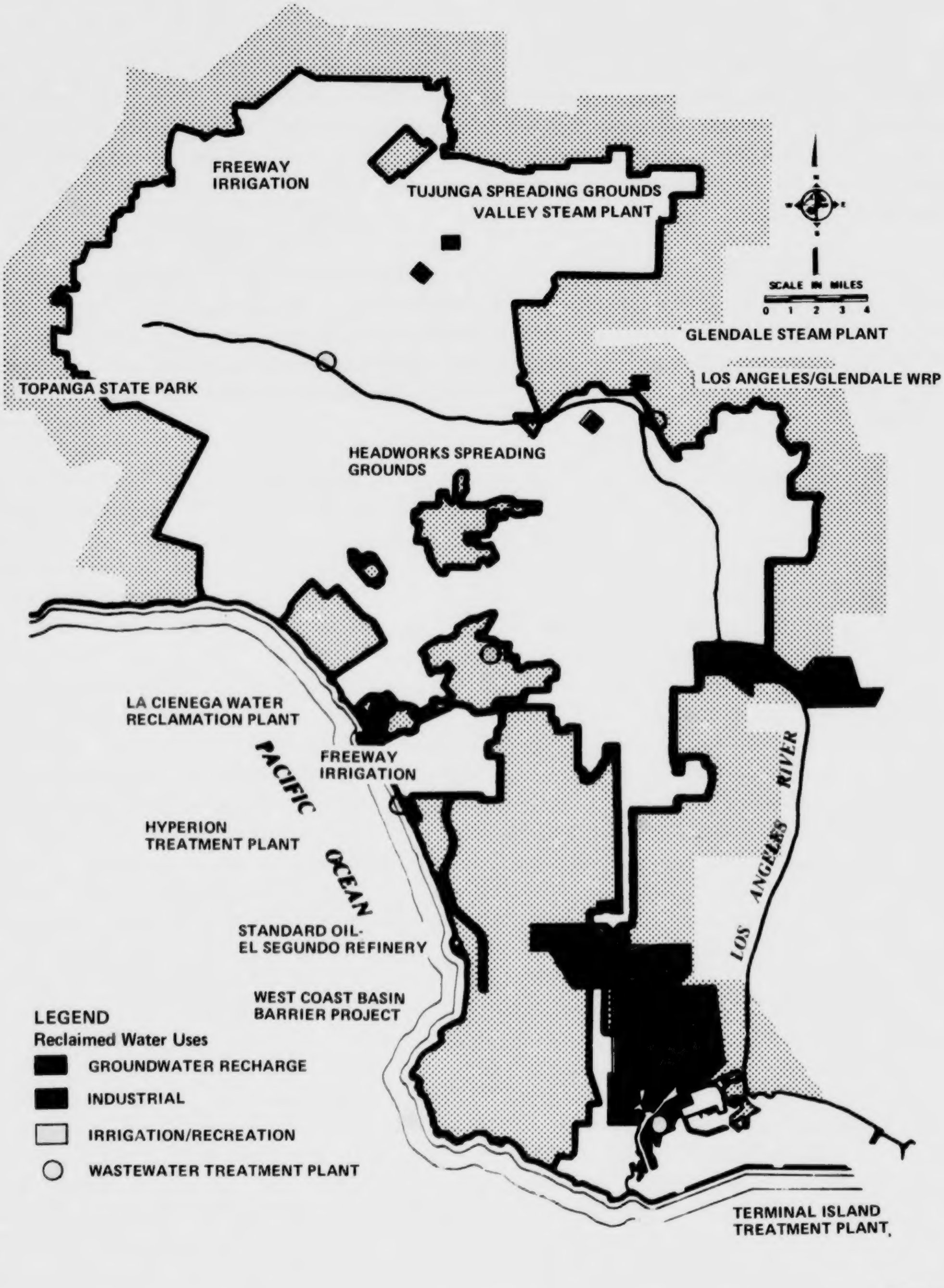
POTENTIAL RECLAIMED WATER USE

	QUANTITY	
USE[1]	mgd	Af/Yr
Groundwater Replenishment by Spreading	45	50,400
Seawater Intrusion Barrier Supply	35	39,200
Industrial Water Supply	85	95,200
Irrigation and Recreation[2]	28	31,400
Total Potential Use	**193**	**216,200**

---

[1] Potential reclaimed water use shown is based on successfuly developing all identified uses that could be supplied from City of Los Angeles wastewater treatment plants.

[2] This use includes providing reclaimed water for fighting fires within the park. Such a use does not involve a significant volume of water on a daily average.


FREEWAY IRRIGATION
TUJUNGA SPREADING GROUNDS
VALLEY STEAM PLANT
SCALE IN MILES
0 1 2 3 4
GLENDALE STEAM PLANT
LOS ANGELES/GLENDALE WRP
TOPANGA STATE PARK
HEADWORKS SPREADING GROUNDS
LA CIENEGA WATER RECLAMATION PLANT
PACIFIC OCEAN
FREEWAY IRRIGATION
HYPERION TREATMENT PLANT
STANDARD OIL-EL SEGUNDO REFINERY
WEST COAST BASIN BARRIER PROJECT
LOS ANGELES RIVER
TERMINAL ISLAND TREATMENT PLANT
LEGEND
Reclaimed Water Uses
GROUNDWATER RECHARGE
INDUSTRIAL
IRRIGATION/RECREATION
WASTEWATER TREATMENT PLANT

198P-426

Figure 3.1. Potential reclaimed water uses.

concerns can be resolved cost-effectively. Groundwater replenishment by spreading consists of the planned application of water on permeable ground where it may infiltrate to the groundwater. The infiltrated water is later extracted and used for municipal consumption.

The San Fernando Valley is the only area within the boundaries of the City of Los Angeles which is geologically suitable for groundwater recharge by spreading. The San Fernando Basin is one of four distinct groundwater basins in the Upper Los Angeles River Area (ULARA) which encompasses the entire drainage of the Los Angeles River (see Figure 3.2). Groundwater from the San Fernando Basin currently provides about 15 percent of the water supply for Los Angeles.

An analysis was made to determine the potential amount of reclaimed water that could be utilized by recharging the San Fernando Basin. This consisted of evaluating the projected water system demands, the available capacity of spreading, extraction and distribution facilities, and water quality considerations. No comparisons with alternative water sources were made at this time; however, this would be necessary to establish the feasibility of this use.

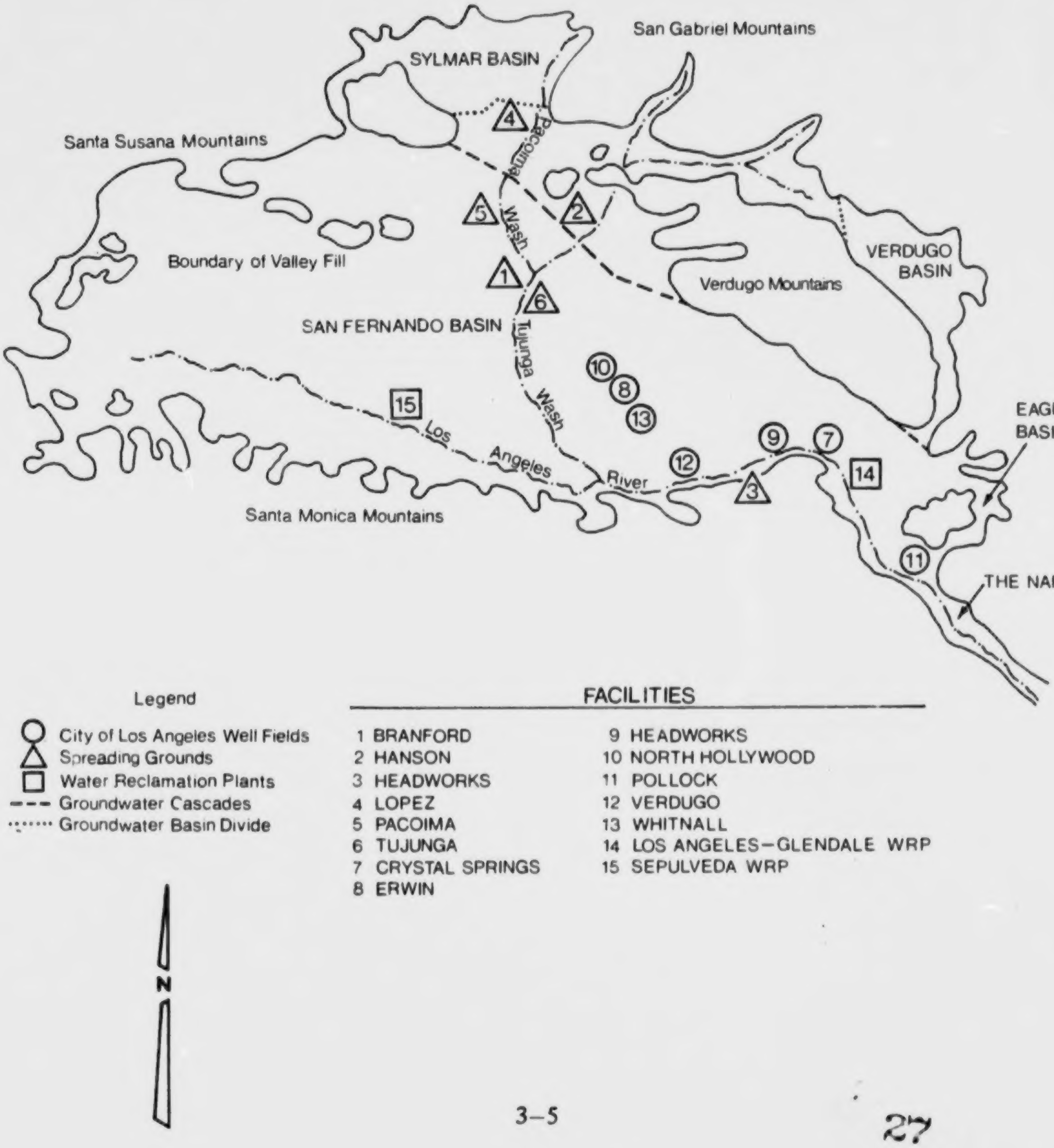
For the purpose of this study, the mean annual water demand for the City of Los Angeles has been estimated to be 900 cfs (581 mgd) in the year 2000. As shown in Table 3.2, this demand would be served from the Los Angeles Aqueduct, local native groundwater production and MWD supplies with MWD supplying the increased future demands. Reclaimed water which is spread and recaptured in the San Fernando Basin could be used to supplant some of the MWD water used in the system.

The primary areas of MWD supply are the Eagle Rock/East Los Angeles and Harbor areas which are projected to use 70 cfs (45.2 mgd) and 48 cfs (31.0 mgd) of MWD water, respectively, in the year 2000 (see Figure 3.3). By analyzing the distribution system, it appears that approximately 50 cfs (32.3 mgd) of MWD supply to the Eagle Rock/East Los Angeles area could be replaced by reclaimed water provided several minor system improvements are made. In order to use more than the estimated 50 cfs (32.3 mgd) of reclaimed water in the Eagle Rock/East Los Angeles area, it would be necessary to make several rather significant and very costly, system improvements. Further system analysis is needed to confirm this 50 cfs (32.3 mgd) estimate and the added costs to increase such use to 70 cfs (45.2 mgd) or beyond to fully eliminate MWD water supply use in the Eagle Rock/East Los Angeles area. The improvements expected to be needed to collect and distribute the entire 70 cfs (45.2 mgd) of groundwater include: wells, collector lines, booster pumps and a major trunk line.

In this study, it was assumed that 70 cfs of reclaimed water would be spread to recharge the groundwater basin. This was done because the basin has been overdrafted in the past, and because there is a substantial usable storage (500,000 acre-feet) in the groundwater basin to accept this excess replenishment for many years. This would result in 50 cfs for distribution and 20 cfs for basin recharge. It should be noted that State Project water and Owens Valley water are also being proposed for storage in this basin for conjunctive use of those supplies in wet and dry years. By the time replenishment has begun (estimated at eight years), more information is expected to be available to make a decision on the improvements necessary to distribute the full 70 cfs.

figure 3.2

UPPER LOS ANGELES RIVER AREA LOCATION MAP


San Gabriel Mountains
SYLMAR BASIN
Santa Susana Mountains
Pacoima Wash
Boundary of Valley Fill
VERDUGO BASIN
Verdugo Mountains
SAN FERNANDO BASIN
Tujunga Wash
EAGLE ROCK BASIN
Los Angeles River
Santa Monica Mountains
THE NARROWS
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Legend
City of Los Angeles Well Fields
Spreading Grounds
Water Reclamation Plants
Groundwater Cascades
Groundwater Basin Divide
N

FACILITIES

1 BRANFORD
2 HANSON
3 HEADWORKS
4 LOPEZ
5 PACOIMA
6 TUJUNGA
7 CRYSTAL SPRINGS
8 ERWIN
9 HEADWORKS
10 NORTH HOLLYWOOD
11 POLLOCK
12 VERDUGO
13 WHITNALL
14 LOS ANGELES–GLENDALE WRP
15 SEPULVEDA WRP

TABLE 3.2

PROJECTED WATER DEMANDS AND SOURCES FOR THE CITY OF LOS ANGELES

YEAR 2000 – NORMAL CONDITION

DEMAND[1]	MEAN ANNUAL FLOW		MAXIMUM DAY FLOW	
	cfs	mgd	cfs	mgd
San Fernando Valley	397	256	795	513
City	449	290	718	463
Harbor	54	35	88	57
Total	**900**	**581**	**1,601**	**1,033**
SOURCES				
Los Angeles Aqueduct	651	420	800	516
Local Native Groundwater [2]	131	85	266	172
Metropolitan Water District [3]	118	76	173[4]	112
Local Reservoir Storage	––	––	362	234
Total	**900**	**581**	**1,601**	**1,034**

[1] Demand based on a population of 3.225 million at 180 gpcd.

[2] Total groundwater pumped based on adjudicated water rights.

[3] MWD supplies Eagle Rock, the East Los Angeles area, and Harbor area at mean annual rates of 70 cfs and 48 cfs, respectively.

[4] Maximum monthly MWD flowrate equals 1.3 times mean annual rates. Maximum day flows may exceed this value.

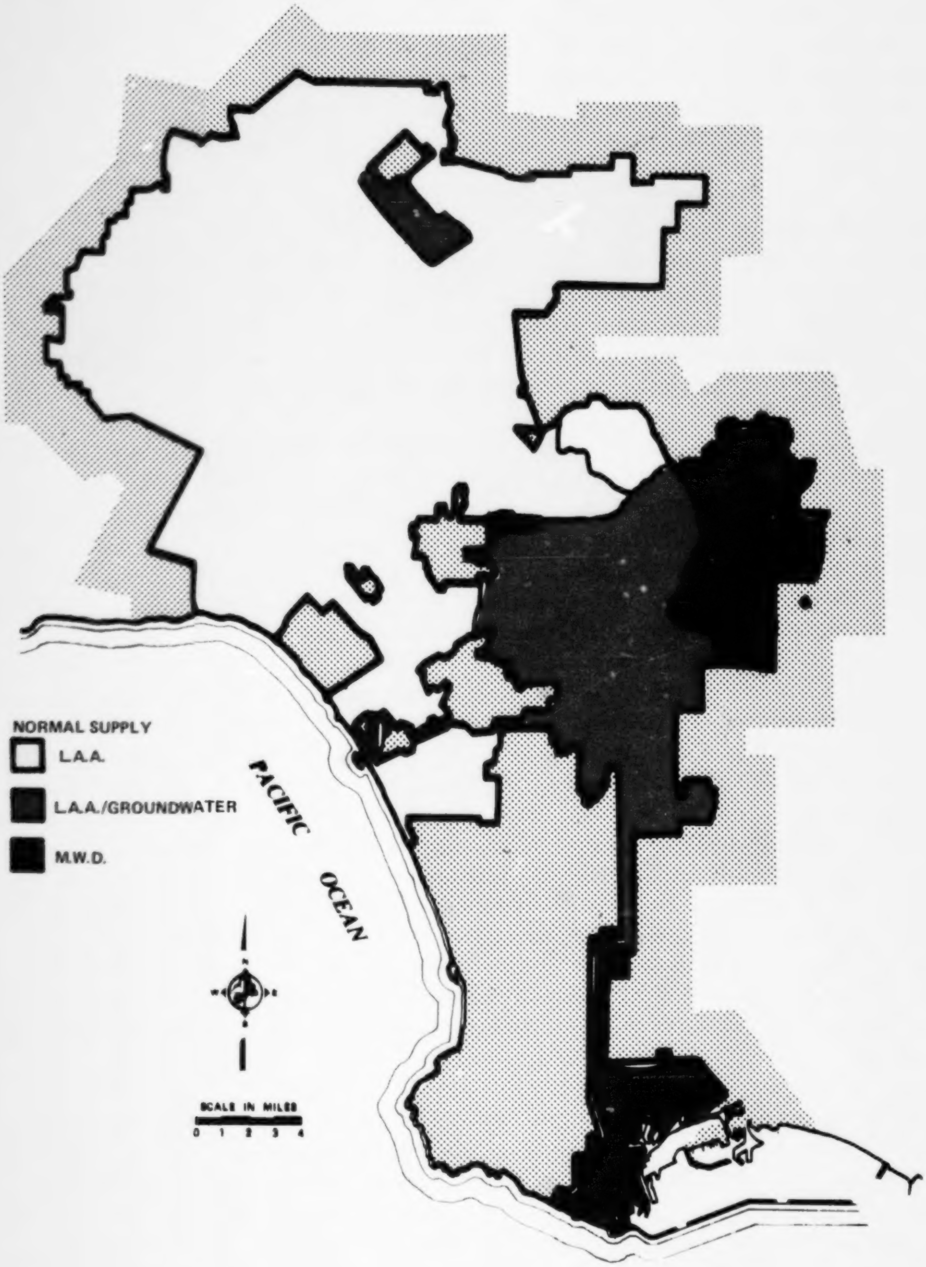

NORMAL SUPPLY
L.A.A.
L.A.A./GROUNDWATER
M.W.D.
PACIFIC
OCEAN
N
W
E
S
SCALE IN MILES
0 1 2 3 4
198P-427

Figure 3.3. Projected water source distribution map, City of Los Angeles—year 2000.

It does not appear feasible at this time to replace MWD supplies in the Harbor area (48 cfs) by further expansion of the groundwater system in the San Fernando Valley as extensive capital improvements would be necessary. However, some additional reduction in MWD deliveries may result from direct distribution of reclaimed water to certain Harbor area industries which have an estimated demand of up to 19 cfs (12 mgd). If these industries are supplied with reclaimed water in conjunction with groundwater recharge in the San Fernando Valley, the total MWD supply needed by the City of Los Angeles could be reduced from 118 cfs (76 mgd) to 49 cfs (32 mgd) in the year 2000.

In order to utilize the 70 cfs of reclaimed water, several conditions must be met. First and foremost, State Department of Health regulations must be met. Second, there must be provisions in the City's groundwater rights to allow the spreading and recapturing of reclaimed water. Third, there must be sufficient capacity in the various facilities that would be used to spread, extract, and distribute the reclaimed water recovered from the underground basin. And fourth, the proposal must ultimately be cost effective, considering broad environmental factors and monetary costs.

The amount of reclaimed water that could be used is a function of health-related water quality factors. Recent draft regulations by the State Department of Health require that the domestic water served contain no more than 50% reclaimed water. To guarantee compliance, they require that: *"Not more than 50 percent of the water entering a groundwater basin at a spreading area during any 12-month period shall be reclaimed water."* However, they go on to say that *"in the absence of this, strong evidence would be required that dilution with natural groundwater would at all times occur."*

The operation of the Los Angeles water system is flexible, in that extracted reclaimed water can be diverted through either the River Supply Conduit to Rowena Reservoir and the Eagle Rock system or the North Hollywood Pump Station to Hollywood Reservoir. In either case, dilution with imported LA Aqueduct water is only possible during part of each year. During peak pumping periods (the summer months), there is not adequate system capacity to provide LA Aqueduct water for dilution. Thus, the 50% dilution requirement would have to be met either by dilution at the point of spreading or dilution by blending with natural recharge water which enters the groundwater basin at many locations. Blending with imported water at the point of spreading may not be a practical solution for Los Angeles, as imported water may not always be available. If the State Department of Health does not accept evidence of dilution underground with native waters, this use could not be developed to the quantity indicated.

The current groundwater rights of the City of Los Angeles in ULARA were determined in August 1975 by the State Supreme Court. Their decision stated that Los Angeles has a Pueblo Right to all the groundwater in the San Fernando Basin derived from precipitation in ULARA and to the return flows of imported water used in the City. The Supreme Court directed the Superior Court to prepare a new judgment outlining the specific groundwater rights of the various parties in the ULARA and to work out physical solutions between the parties in the decision.

A key point in the Supreme Court decision is that Los Angeles may extract an amount of water equal to the amount of imported water it spreads. This is likely to be applicable to reclaimed water as it is primarily of imported origin.

There are six recharge areas within the San Fernando Basin as shown on Figure 3.2. The Headworks and Tujunga Spreading Grounds, which are operated by the Department of Water and Power, are most likely to be used for recharge with reclaimed water. Based on average infiltration rates, the maximum capacities of these spreading grounds are 35 cfs at Headworks and 100 cfs at Tujunga. The Headworks Spreading Grounds is currently used for the percolation of approximately 10 cfs of runoff diverted from the Los Angeles River channel. Tujunga is currently used to percolate about 1.5 cfs of natural runoff and occasionally imported Owens Valley water. It is assumed that the spreading of runoff will be discontinued at Headworks when reclaimed water is available for spreading, but that at Tujunga will continue. Thus, the spreading capacity available for reclamation would be 133.5 cfs, which is more than adequate to handle the projected maximum potential use of 70 cfs.

The Department operates seven well fields in the San Fernando Basin for domestic consumption purposes. These are the North Hollywood, Erwin, Whitnall, Verdugo, Headworks, Crystal Springs and Pollock well fields as shown in Figure 3.2. These wells are estimated to have a combined sustained peak capacity of 265 cfs, of which about 115 cfs is currently utilized for groundwater production and domestic supply on a mean annual basis. Much of the remaining capacity is pumped during periods of high demand. The difference between mean annual rates and peak capacity (150 cfs), less any additional pumping capacity used in conjunction with the spreading of Owens Valley water in the San Fernando Valley, could be used to extract reclaimed water. It is assumed that there is sufficient capacity to handle the projected 50 cfs of reclaimed water on a mean annual basis. However, according to demand projections, an additional 122 cfs of capacity is required for peaking (maximum day). This total required capacity of 287 cfs would require modifications to increase the capacity of the North Hollywood Pump Station so that additional well water could be pumped to Hollywood Reservoir.

An additional condition requiring investigation is the availability of capacity in the distribution system to convey pumped groundwater to the desired area. It is estimated that the following conditions would exist in the distribution system if a reclamation program (50 cfs distribution capacity) such as discussed here were implemented:

1) MWD water now delivered at Eagle Rock Reservoir would be replaced by well water from the River Supply Conduit (RSC) via the Rowena Pump Station and the Eagle Rock–Hollywood conduit, and the Hollywood Reservoir service area would be supplied with well water via the North Hollywood Pump Station.

   Note: Additional distribution capacity would probably be needed if the maximum proposed reuse project (70 cfs) were developed.

2) LA Aqueduct water previously used in the service areas of Hollywood Reservoir would be used in the San Fernando Valley and western portions of the City, assuming these areas experience the projected growth.

The current flows in the RSC and Hollywood Reservoir Inlet Line are very near the design capacities of these lines. The distribution of the additional water available from reclamation (50 cfs) could probably be handled if LA Aqueduct water is displaced to the west. If the level of reclamation is increased to 70 cfs, additional distribution capacity

TABLE 3.3

PROJECTED WATER DEMANDS AND SOURCES FOR THE CITY OF LOS ANGELES

YEAR 2000 – WITH RECLAIMED WATER SUPPLY

	Mean Annual Flow		Maximum Day Flow	
Demand[1]	**cfs**	**mgd**	**cfs**	**mgd**
San Fernando Valley	397	256	795	513
City	449	290	718	463
Harbor	54	35	88	57
Total	**900**	**581**	**1,601**	**1,033**
Sources				
Los Angeles Aqueduct	651	420	800	516
Local Native Groundwater [2]	131	131	266	172
Reclaimed Water (Groundwater Replenishment[3]	50	32	65	42
Metropolitan Water District[4]	68	44	108[5]	70
Local Reservoir Storage	––	––	362	234
Total	**900**	**581**	**1,601**	**1,034**

[1] Demand based on a population of 3.225 million at 180 gpcd.

[2] Native groundwater pumped is based on adjudicated water rights.

[3] Reclaimed water via groundwater recharge replaces MWD supply to the East Los Angeles area. Note constraints on potential use given in text.

[4] MWD supplies only the Harbor area.

[5] Maximum monthly MWD flowrate equals 1.3 times mean annual flowrate. Maximum day flows may exceed this value.

would probably be required. The cost of such construction could impact the cost of this proposed use.

In summary, there is a potential to develop 50 cfs (32 mgd) of reclaimed water by groundwater replenishment in the San Fernando Valley. This would consist of spreading reclaimed water at the Headworks and Tujunga Spreading Grounds, extracting the water at the various well fields in the San Fernando Basin and distributing the water recovered in the Eagle Rock/East Los Angeles and Central Los Angeles areas of the City. This reclaimed water would replace MWD supplies used in these areas and would meet the needs for additional water sources in the year 2000 as shown in Table 3.3. Some additional reduction in MWD supplies would result from water reclamation in the Harbor industrial area.

A study of various water quality aspects of water reclamation in the San Fernando Valley is currently being planned by the Department of Water and Power. This study should result in recommendations for advanced treatment and spreading ground operations to ensure a reclaimed water quality meeting the Health Department requirements. A request has been submitted to the California Regional Water Quality Control Board, Los Angeles Region, to include this study for funding on their Fiscal Year 1977–78 Clean Water Grant Project List. This request is currently included in a proposed areawide water reclamation study.

Seawater Intrusion Barrier Supply

Efforts to develop water reclamation as a source of supply for a seawater intrusion barrier have been actively pursued since the mid-1950s. This use would involve the injection of water into an aquifer to create a freshwater pressure mound which prevents the flow of seawater into the aquifer. Water imported by MWD is presently being used as a source of supply. If reclaimed water could be supplied for this use, the MWD water could be made available for domestic consumption or the amount of water imported could be decreased.

The only seawater intrusion barrier that has been considered for use of reclaimed water from the City of Los Angeles Wastewater System is the West Coast Basin Barrier Project (see Figure 3.4). Payment for the water injected in this barrier is collected by the Central and West Basin Water Replenishment District (C&WBWRD) through pumping assessments. This project is operated by the Los Angeles County Flood Control District and includes a series of injection wells, supply pipelines and other facilities which are located parallel to the coastline between Los Angeles International Airport on the north and the Palos Verdes Hills on the south. The estimated water use for the Barrier for 1976–77 is 33,000 af/yr (30 mgd or 45 cfs) as a result of recently constructed additional injection wells. Estimates for reclaimed water use made in 1974 were for 35 mgd (39,000 af/yr or 54 cfs) and this estimate was used in this report.

Imported water supplied by the Metropolitan Water District from the Colorado River, and more recently from the California Aqueduct has been the source of supply for the barrier throughout its operation; however, alternate water supplies have been studied. Investigations were made in 1955–57, and again in 1962–63, by the Flood Control District to determine if reclaimed water could be used for injection. Those investigations led to the conclusion that reclaimed water could be injected, and could probably be produced at a cost which is competitive with future supplemental waters available from MWD.

In 1967, the Central and West Basin Water Replenishment District sent a letter to the City of Los Angeles requesting information about the feasibility of the use of reclaimed water from the Hyperion Treatment Plant as an alternate water supply for the barrier. In response to this letter, the Department of Water and Power undertook bench studies and the operation of a pilot plant from 1968 through 1970 to investigate the question. The results of the pilot studies showed that a nitrified secondary effluent from Hyperion could be treated using activated carbon to produce water of a quality anticipated to be acceptable for injection. Additional studies involving actual injection of reclaimed water in the barrier were proposed to confirm the findings of the pilot test and to investigate water quality concerns prior to developing a full-scale reclamation project.

In 1972, the Department developed cost estimates for this proposed reclaimed water supply which indicated that reclaimed water could be produced at a cost of $49 per acre-foot (1972 dollars). The 1972 cost for Colorado River water purchased at the replenishment water rate was $32 per acre-foot. Although this was less than the cost for reclaimed water, expected future price increases by MWD were anticipated to raise the price for this water to about $70 per acre-foot, or higher. Thus, reclaimed water appeared to be economically feasible in the future although not immediately. Since additional development work (demonstration studies) required to confirm technical feasibility would take 5 to 10 years, it was believed that use of reclaimed water would be economically feasible by the time a full-scale facility could be constructed (approximately 1980).

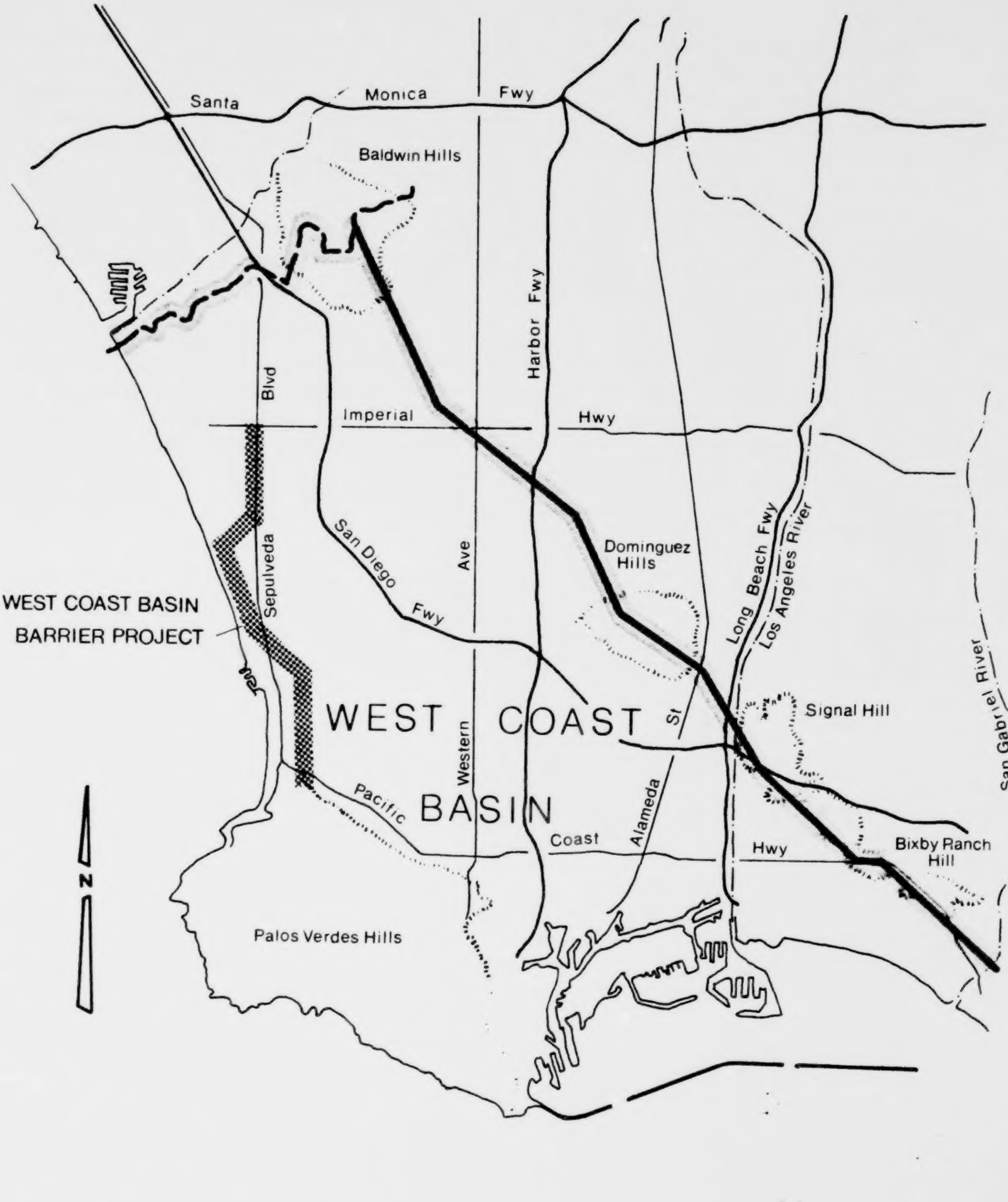
Based on the above costs, the Department prepared a project report which presented a 2 mgd demonstration project needed to confirm the technical feasibility of the project. This report was reviewed by the State Water Resources Control Board, in accordance with FY 1972–73 Clean Water Grant requirements, who determined that the full scale water supply alternatives were insufficiently developed to show that reclaimed water was the most feasible source for the barrier.

As a result, a re-evaluation of three barrier water supply alternatives was made in 1974 based on new data. The three alternatives to be evaluated were the current imported water supply, reclaimed water, and desalinated seawater. This evaluation indicated a number of potential water quality problems with the reclaimed water alternative which required higher levels of treatment than previously anticipated to provide the necessary reliability. Consequently, the cost to treat and deliver reclaimed water increased to a range of $73–$113/af.

Coupled with this evaluation of the full scale alternatives was a more thorough evaluation of the costs and the required revenues to conduct the proposed demonstration studies. In 1972, it was determined that the Replenishment District would pay $45/af for reclaimed water used in the barrier during the demonstration studies. An agreement to conduct these studies was being negotiated between the three agencies at that time. However, the more recent evaluation in 1974 indicated the price for reclaimed water purchased by the Replenishment District during the demonstration studies would be in the range of $135–$155/af. This increase was the result of 1) a significant expansion in the scope of the studies to satisfy health concerns, 2) reductions in the anticipated

figure 3.4

WEST COAST BASIN BARRIER PROJECT


Santa
Monica
Fwy
Baldwin Hills
Blvd
Harbor Fwy
Imperial
Hwy
Sepulveda
San Diego
Fwy
Ave
Dominguez Hills
Long Beach Fwy
Los Angeles River
WEST COAST BASIN BARRIER PROJECT
WEST COAST BASIN
Western
St
Alameda
Signal Hill
San Gabriel River
Pacific
Coast
Hwy
Bixby Ranch Hill
N
Palos Verdes Hills

amounts of grant funding, 3) equal sharing of the development costs between the Department and the Replenishment District, and 4) inflation.

The Replenishment District decided that the monetary cost of the proposed reclaimed water supply to the barrier was no longer favorable and that the cost of development was too high in comparison with the previous estimates. Further development of the project was subsequently suspended.

A number of problem areas exist that are finding further development of this reclaimed water use in the areas of funding and water quality. These problems manifested themselves in a difficulty in negotiating an agreement to conduct the demonstration studies. The necessary investment in demonstration studies required substantial funding from both Federal grants and the local agencies. Since the grants were not available in the amounts originally anticipated, the local agencies were required to fund more than one-third of the cost of the studies. The Replenishment District did not have the money available to fund their share of the project and was unwilling to accept any significant amount of financial liability if the project failed. The Department, in turn, was unwilling to participate in a project where it was required to accept most of the financial liability. Thus, funding proved a major obstacle.

Health and water quality concerns were another major problem area. Although the State Department of Health had not developed water quality criteria for this use, discussions with the staff of that Department indicated that strict water quality requirements must be adhered to. The Replenishment District being responsible for water quality maintenance in the groundwater basin showed that belief. Thus, substantial amounts of treatment were required to insure that a safe water was injected. This resulted in significant cost increases (range of $73–$113/af) such that reclaimed water could not be competitive with the $37/af cost for imported water.

If these problems of funding and water quality are resolved in the future, a potential reclaimed water use of up to 35 mgd could be developed from the Hyperion Treatment Plant. At this time, it appears that funding of the project will continue to be a major problem that cannot be resolved.

Industrial Water Supply

The use of reclaimed water as a source of industrial water supply has been under consideration for a number of years in the Los Angeles area. The principal industrial use to be made of reclaimed water is for cooling tower makeup with smaller amounts for process water.

Several steps were followed in developing information on potential industrial water uses. First, concentrated industrial areas were identified from land use and zoning maps. Areas of high water use were also identified. From this information, potential market areas were identified and surveys were conducted to determine more accurately the industrial water use in the area. If an area had a particularly small use and was a significant distance from a wastewater treatment plant, it was screened out of any additional evaluation in this report. Those industrial use areas remaining constituted the major uses used in more detailed evaluations.

TABLE 3.4

PROJECTED INDUSTRIAL WATER USE FOR THE EL SEGUNDO AND CARSON – TORRANCE AREAS

Industry	Location	Water Use[1] mgd
Allied Chemical	El Segundo	1.2
Atlantic Richfield	Carson – Torrance	14.7
Fletcher Oil	Carson – Torrance	0.1
Golden Eagle	Carson – Torrance	0.1
Mobil Oil	Carson – Torrance	8.3
Shell Oil and Chemical	Carson – Torrance	6.7
Standard Oil	El Segundo	8.0[2]
Stauffer Chemical	Carson – Torrance	0.2
Texaco	Carson – Torrance	5.2
Union Oil	Carson – Torrance	8.3[3]
Miscellaneous Industries	Carson – Torrance	2.0[4]
TOTAL		**54.8[5]**

[1] Data based primarily on a 1967 survey of refineries unless noted otherwise. Figures represent 1990 projections.

[2] Standard Oil water use based on discussions with that company.

[3] Union Oil use based on a 1973 survey of Los Angeles Harbor area industries.

[4] Estimated – no data available.

[5] Total industrial demand could be lower than this since not all industrial uses within any industry could be supplied by reclaimed water.

The areas of highly concentrated industry and water use are in the El Segundo area, the Carson–Torrance area, the Los Angeles Harbor area, the Vernon–Commerce area, and some smaller localized areas in the San Fernando Valley. Several of these potential markets are outside of Los Angeles and presently receive their water supply from another water purveyor. Developing reclaimed water markets in those areas will involve additional problems that would not exist for markets within the City. These problems will be discussed later. Of these areas, surveys were conducted in El Segundo, Carson–Torrance, and Los Angeles Harbor, to determine potential reclaimed water use. Several specific uses were also identified in the San Fernando Valley. Due to time constraints, the Vernon–Commerce area has not been surveyed. Potential reclaimed water use for this area was assumed from a list of large water users supplied by the City of Vernon.

In 1967, a survey of the major refineries in the El Segundo and Carson–Torrance areas was conducted to determine the potential market for reclaimed water. This survey indicated that ten refineries and chemical companies had uses which could accept reclaimed water as a supply for a total potential projected 1990 use of 53 mgd. A list of the companies responding with their respective water uses are shown in Table 3.4. Some of the water use figures given in this table have been updated based on more recent information from other surveys. In addition to these surveyed industries, there are several other water-using industries in the Torrance area, such as U.S. Steel, Martin-Marietta Aluminum and Union Carbide that might be included in the prospective market for reclaimed water. It will be assumed that these other industries could add a total of 2 mgd of water to the potential market. Thus, the total industrial water use in this area which could, theoretically, be supplied from a reclaimed water source is 55 mgd of which 9 mgd is from the El Segundo area and 46 mgd is from the Carson–Torrance area. It should be noted that these figures are to be used for comparison of wastewater disposal alternatives only and do not in any way constitute firm demands.

A similar survey was conducted in the Harbor area in 1973 in response to a request from the Sun Oil Company about reclaimed water for oil well pressurization. The results of this survey, which are shown in Table 3.5, indicate a potential market of approximately 5 mgd in the Harbor area. These uses are highly varied, ranging from cooling tower makeup through oil-well pressurization to general shipyard use.

Another potential reclaimed water market for industrial use is in the Vernon–Commerce area. This area has widely varied industrial uses, including rubber and paper production, metal fabrication, glass, chemicals, and others. At this time, no data are available on the industries potentially able to use reclaimed water in the Vernon–Commerce area because surveys have not been conducted. For purposes of comparing wastewater disposal alternatives, it will be assumed that an industrial water use of 20 mgd can potentially be developed in this area. It is recommended that surveys be conducted in this area to determine the actual use and desire by industries to use reclaimed water.

The San Fernado Valley also has some potential for industrial water use. However, most of the uses are quite small and widely scattered which would not be feasible to supply. There are three fossil fuel power plants in the San Fernando Valley which utilize cooling towers: the Burbank Steam Plant, the Glendale Steam Plant, and the City of Los Angeles Valley Steam Plant. Reclaimed water is currently being supplied to the Burbank Steam Plant for cooling tower makeup from the Burbank Water Reclamation Plant. The

TABLE 3.5

PROJECTED INDUSTRIAL WATER USE FOR THE LOS ANGELES HARBOR AREA

Industry	Water Use[1] mgd
Bethlehem Steel	0.1
Canner's Steam	0.3
Collier Carbon	0.1
Exxon	1.0
Great Lakes Carbon	2.2
McDonnel – Douglas	0.5
Todd Shipyards	0.3
Union Carbide – Linde Division	0.1
U. S. Borax	0.3
TOTAL	**4.9**[2]

[1] Use based on 1973 survey of large water users in the Los Angeles Harbor area. Data on Union and Shell Oil was included in Table 3.4. Figures represent 1990 projections of potential market.

[2] Total industrial use of reclaimed water would be lower since not all industrial uses within any industry could be supplied by reclaimed water.

TABLE 3.6

POTENTIAL INDUSTRIAL WATER USES – SUMMARY

Location	Estimated Use[1] mgd
El Segundo area[2]	9
Carson – Torrance area[3]	46
Los Angeles Harbor area[4]	5
Vernon – Commerce area[5]	20
San Fernando Valley area	5
TOTAL[6]	85

[1] Data summarized from Tables 3.4 and 3.5 and from text. Some uses are reduced by later discussion.

[2] Has been under consideration for 10 years with several significant problems still halting development.

[3] Has been under consideration for many years. Costs to develop and use are significant problems.

[4] Waste discharge requirements could be a significant problem.

[5] No data or contacts – a guesstimate.

[6] Assumption of complete replacement of all uses considered very optimistic.

other two plants could also use reclaimed water with a potential for using 3 mgd at the Glendale Steam Plant and 2 mgd at the Valley Steam Plant for a total San Fernando Valley use of 5 mgd. Of these, there is a water reclamation plant under construction to supply reclaimed water to the Glendale Steam Plant from the LA–Glendale Water Reclamation Plant.

The potential exists to reclaim a maximum of 85 mgd of wastewater for industrial water supply purposes as shown in Table 3.6. These industrial uses are primarily cooling tower makeup with smaller amounts for process and boiler feed water. However, these industrial uses exist in five separate areas of the City of Los Angeles and surrounding communities: El Segundo area, Carson–Torrance area, Los Angeles Harbor area, Vernon–Commerce area, and San Fernando Valley area. Some entire areas may prove infeasible to develop due to administrative and cost problems so the market is extremely weak at this time.

Before reclamation for industrial use can be proposed, additional marketing analysis is necessary to adequately determine the quantity and quality of reclaimed water that might be used in the various industrial areas. Such a study has been proposed by the Department of Water and Power. The initial steps toward having this work funded by the Clean Water Grant Program have been taken and the project will be included on the Fiscal Year 1977–78 Clean Water Grant Project List as a part of a proposed areawide water reclamation study.

There are currently a number of constraints which are impeding the development of reclaimed water for industrial supply. These include primarily water quality requirements, negotiation of agreements with other water purveyors, and water quality requirements for the use. In addition, there is a need to determine whether the City or the County Sanitation Districts could supply these areas more economically.

A major constraint to the development of reclaimed water markets is the impact of industry's use of reclaimed water on their current industrial discharge requirements. Wastewater collected and treated by the Department of Public Works and then reclaimed by DWP for industrial purposes would contain a certain amount of inorganic wastes. Industrial use of this water would further concentrate these wastes and change the point of discharge, although there would be no change in the total waste loading to the receiving water. Under current Ocean Plan regulations, the industry would be required to return their used reclaimed water to a wastewater plant for discharge, thus limiting their operational flexibility and increasing costs. Regulatory agencies will have to develop a procedure which would allow industry to use reclaimed water and not be penalized for the amount of waste already in the water before any significant reuse activities are pursued. A case in point is the Standard Oil El Segundo Refinery. Coordination has been going on for the past 10 years toward reclaiming water for cooling tower makeup at this refinery. However, the current Ocean Discharge Plan would not allow the blowdown from reclaimed water use to be discharged to the ocean as the waste load is above the prescribed standards. As a result, the development of this potential use has been essentially halted. Revisions to the Ocean Plan are currently underway which may resolve this problem allowing reclamation to proceed.

Another major problem area involves agreements with other water purveyors. Most of the potential market areas identified are located outside the City of Los Angeles.

Thus, many local water companies are involved in the decision to develop a reclaimed water supply. One of the primary concerns involves loss of revenue by reducing the amount of water sold by the water companies. This problem and other jurisdictional problems must be resolved by agreements between each water agency involved.

In many cases, the quality of reclaimed water available will not be consistent with that which the industry desires. The use of reclaimed water could result in some additional cost to the industry for treatment to achieve the desired quality. This penalty cost must be included in any economic evaluation of reclaimed water.

Another potential constraint to the development of reclaimed water for industrial uses is competition between the City and County Sanitation Districts for several market areas. The Southwest Los Angeles and the Vernon–Commerce Industrial Areas could be served from either wastewater system. Thus, a joint evaluation of these market areas may be necessary to determine which agency, if any, could supply reclaimed water in the most cost-effective manner.

In summary, there are a number of potential reclaimed water market areas for industrial use in the Los Angeles area. The development of this use cannot occur until the constraints outlined above are adequately resolved.

Irrigation and Recreation Water Supply

Irrigation and recreation water supply respresents a potentially feasible use of reclaimed water. State Department of Health regulations do restrict these uses to some extent but such restrictions are relatively liberal and would allow significant use to occur. The primary uses for reclaimed water consist of park, golf course, and cemetery irrigation, freeway landscape irrigation, ornamental and recreational lakes, stream flow augmentation, and fire protection. Irrigation and recreation uses do not occur where they could impact the choice between the wastewater disposal alternatives. However, they are included here to illustrate the potential use which may be made of the two inland treatment plants.

There are two existing and two proposed major park areas where a market for reclaimed water for recreation and irrigation might be developed. The existing parks are Griffith Park and the Sepulveda Basin Recreation area; the proposed parks are the Baldwin Hills Regional Park and the Topanga State Park. In addition, studies of infrared satellite imagery of the Los Angeles Basin and various planning maps have shown many smaller parks, golf courses, landfills and cemeteries in the Santa Monica Mountains, and on the coastal plain which could also be irrigated with reclaimed water. Other proposed uses include freeway landscape irrigation and the formation of man-made recreational lakes in the Los Angeles River Flood Control Channel. However, all such uses represent small variable demands which are generally too costly to supply economically. These uses will probably not develop unless an industrial supply line is installed to serve the same area.

Griffith Park

Griffith Park, located at the eastern terminus of the Santa Monica Mountains, is the largest single park development in the City of Los Angeles. With an aggregate area of approximately 4,200 acres, this park contains a diversity of recreational facilities, including golf courses, picnicking and playground area, a zoo, and hiking and equestrian trails. The draft Griffith Park Master Plan (1974) showed new uses of 8.3 mgd for the golf course and picnic areas that might be supplied by reclaimed water. The recreational use of reclaimed water would consist of a limited number of ponds and marshes and possible streams. Lakes would be developed in the existing golf courses and in several of the park's canyons. Fire-fighting provisions would consist of a system of fire hydrants along all major existing roads supplied by reclaimed water. The estimated maximum potential for reclaimed water use in Griffith Park is 10 mgd. The majority of this hypothetical demand is based on new uses not currently being supplied.

Currently, a 2-million gallon tank, transmission pipeline and pump station have been installed to supply reclaimed water from the Los Angeles–Glendale Water Reclamation Plant to the park. Studies are now underway by Keith and Associates to convert the existing water system in the Wilson and Harding golf courses and the Crystal Springs picnic area to a dual water system with irrigation from the reclaimed water system and domestic uses from a separate domestic water system. This initial phase is estimated to have a demand of 5 mgd. The actual amounts of reclaimed water to be used throughout the park in the future will depend on the outcome of a new park Master Plan currently in preparation by the SWA Group. These proposals have been under consideration for 10 years and reclaimed water is still not being used. The completion of the LAGWRP in 1976 and grant agreements related to that facility are expected to result in the use of reclaimed water for irrigation in parts of Griffith Park in the near future.

Sepulveda Basin Recreation Area

The City of Los Angeles has a long-term lease agreement with the U.S. Army Corps of Engineers for development of recreational facilities in the 2,000-acre Sepulveda Flood Control Basin. This area is located northwest of the San Diego and Ventura Freeway interchange. To supplement existing recreational facilities, the City Department of Recreation and Parks has prepared a Master Plan for development of the Basin which includes five 18-hole golf courses, numerous areas for picnicking and hiking, a model airplane field, a wildlife refuge, and other recreational facilities. Currently, three golf courses and several park areas have been developed.

Preliminary estimates of the ultimate irrigation and recreation water needs for all recreational facilities in the Basin, both existing and proposed, are approximately 9 mgd. These estimates are based on current water usage for the existing facilities and the ultimate development of facilities in the basin. The use of reclaimed water here would displace the use of the domestic water currently purchased by the Department of Recreation and Parks from the Department of Water and Power. The construction of these recreation facilities is not contingent on the availability of reclaimed water.

Baldwin Hills Regional Park

The Los Angeles County Department of Parks and Recreation has recently proposed to acquire and develop approximately 1,300 acres of land for park purposes in the Baldwin Hills area. At present, this land is largely devoted to oil extraction. The park development will occur as the oil-related activity is phased out over a period of time, due to exhaustion of the supply of petroleum in the fields. Development plans are only in the conceptual stages; however, the intent is to provide a wide range of regional recreation activites. These would include picnicking, overnight camping, nature study, hiking, bicycling, baseball, tennis, swimming, and other recreational activites where suitable to the site.

Estimates of the amount of water use have not been made because of the conceptual nature of the plans. Based on the size of the proposed development, and normal irrigation procedures, this park could utilize between 1 and 6 mgd of water for irrigation and recreation purposes. If reclaimed water is not available, domestic water would be supplied by either DWP or Culver City. Time tables for implementation of park development have not yet been established; however, it is estimated that the entire park will not be developed for at least 20 years (1995).

Topanga State Park

The Topanga State Park consists of approximately 7,000 acres of land in the Santa Monica Mountains. There are no existing plans for development of this park, and it is currently estimated that much of the land will be kept in a natural state with no irrigation. The park may have a water need for fire protection, but this would not constitute a significant water demand. No estimates of potential water use can be made at this time.

Miscellaneous Uses

Many smaller potential uses may also exist in the Los Angeles area. These include irrigation and recreation uses at various regional parks and cemeteries, freeway landscape irrigation, and recreational lakes in the Los Angeles River. Each of these uses represent small demands which would not be expected to be cost-effective by themselves. Their development would be dependent on the availability of an existing nearby reclaimed water system such as might be developed for industrial water supply. As a result, the estimated 4 mgd demand for irrigation of the smaller parks and freeway corridors could not be implemented prior to completion of an industrial water system.

One small use that could be implemented in the near future is an irrigation system along Imperial Highway and Pershing Drive near the Los Angeles Airport. This system is in the advanced planning stages and the necessary environmental documents have been approved. The uniqueness of this system is its close proximity to the Hyperion Treatment Plant.

Recreational lakes in the Los Angeles River Flood Control Channel represent another potential use. Treated wastewater discharged into the river channel could be used to form lakes behind collapsible rubber dams which would allow the passage of flood waters.

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TABLE 3.7

POTENTIAL IRRIGATION AND RECREATION WATER USE

LOCATION Firm Commitment[1]	Estimated Demand mgd
Griffith Park	5.0
Sepulveda Basin Recreational Area	9.0
Subtotal	**14.0**
Other Potential Uses[2]	
Griffith Park[3]	5.0
Baldwin Hills Regional Park	[4]
Topanga State Park	[4]
Miscellaneous Parks and Cemeteries	3.5
Freeway Landscape Irrigation	0.5
Los Angeles River Lakes	5.0
Subtotal	**14.0**
TOTAL DEMAND	**28.0**

[1] These uses may be implemented in the near future.

[2] These uses may be implemented but are in the planning stages or require the existence of a larger industrial water system as a source of supply.

[3] Additional demand contingent on current City Planning efforts.

[4] Insufficient data available to make estimates.

Additional treatment facilities would have to be provided to maintain the water quality in the lakes. Although this use has merit from a recreational viewpoint, it would have to be fully evaluated before any commitment could be made to the use. The estimated demand for these lakes is 5 mgd. The availability of water would depend on the degree of reclamation implemented at upstream treatment plants. At this time, very little interest has been shown on this use, since the river flows through the industrial area of town for much of its length and the setting for a lake would not be very attractive. The natural flow in the river is about 10 cfs (6.4 mgd) so there has been enough water for limited lake development for many years. No such development has occurred.

In summary, there is a total maximum potential need for irrigation and recreational water of 28 mgd which could be supplied by reclaimed water as shown in Table 3.7. Of this potential demand, only 14 mgd is likely to be implemented at Griffith Park and Sepulveda Basin. The implementation of an additional 5 mgd at Griffith Park is contingent on the outcome of the current planning efforts. These two parks have sufficient need by themselves to justify separate water supply systems. The remaining potential use is not likely to be implemented unless a larger reclaimed water system such as for industrial supply is constructed that can supply the smaller uses.

3.2 WATER QUALITY CRITERIA

The key point in considering water quality criteria is that the water served should have a quality that is consistent with the proposed use. Thus, water used for irrigation purposes would theoretically have different water quality criteria from water used for groundwater replenishment. The purpose of this section is to present water quality criteria for each reclaimed water use. These criteria are then used in assessing the quality of reclaimed water available and in developing any required advanced treatment for wastewater treatment plant effluents.

Other water quality considerations involve adequate safeguards to protect domestic water supplies from contamination by reclaimed water. Backflow prevention devices are especially important when dual water systems are proposed as for industrial or irrigation uses.

Groundwater Replenishment by Spreading

The State Department of Health has recently released a revised draft of their proposed groundwater recharge regulations for comment. These regulations prescribe criteria for reclaimed water intended for recharge by surface spreading to or into a groundwater basin that is used or is suitable for a source of water supply for domestic purposes. The regulations prescribe interim criteria, and thus, are subject to modification as more information becomes available.

The proposed regulations require, as minimum treatment, an adequately oxidized wastewater by conventional secondary treatment followed by carbon adsorption and percolation through an unsaturated zone of undisturbed soil for a minimum vertical distance of 10 feet. This minimum treatment chain must be supplemented by various operational controls. The regulations are designed to assure that the quality of the reclaimed water after treatment and soil percolation meets the mandatory chemical and physical standards for drinking water in California. Effective performance of the

TABLE 3.8

WATER QUALITY CRITERIA[1] FOR VARIOUS RECLAIMED WATER USES

CONSTITUENT[2]	GROUNDWATER REPLENISHMENT		INDUSTRIAL WATER COOLING	IRRIGATION		RECREATION IMPOUNDMENTS	
	Spreading	Injection		Agricultural	Landscape	Non-restricted	Restricted
Total Dissolved Solids	700	700	700	1,000	2,000		
Total Hardness	—	—	130	—	—		
Alkalinity	—	—	20	—	—		
Percent Sodium	—	—	—	—	—		
Boron	1.5	1.5	—	1.0	1.0		
Chloride	100	175	500	100	250		
Fluoride	1.2	1.2	—				
Heavy Metals	[3]	[3]	—				
Ortho-Phosphate (Ortho PO_4)	—	—	2				
Silica	—	—	50				
Sodium	—	—	—	120	350		
Sulfate	300	175	200	—	250		
pH	6.5–9.0	6.5–9.0	6.5–7.5	—	—		
COD	5	15	40	—	40		
TOC	3	—	—	—	—		
Color	—	—	—	—	—		
TKN	6	6	—	—	—		
NH_3–N	—	—	1.0				
$(NO_2 + NO_3) - N$	10	10	10				
MBAS	0.5	0.5	1.0				
Suspended Solids	—	5	5				
Turbidity FTU	—	1.0	—	5	10	5	
Coliform Index (mpn/100 ml)	2	2	2.2	2	23	2	2
Treatment Level[4]				I/II	III	I	II

[1] Criteria based on references 3.2, 3.6, 3.7, 3.9 – 3.12.

[2] All concentrations expressed in mg/l unless otherwise noted and represent maximum concentrations.

[3] Concentrations shall not exceed Drinking Water Standards.

[4] Treatment levels indicated by California Department of Health (arbitrary).
Level I – Oxidized, coagulated, filtered, and disinfected wastewater.
Level II – Oxidized, and disinfected wastewater (2.2 coliform mpn/100 ml).
Level III – Oxidized, and disinfected wastewater (23 coliform mpn/100 ml).

treatment process and indication of efficient organic removal is substantiated by meeting the limits specified for chemical oxygen demand (COD) and total organic carbon (TOC) which are 5 mg/l and 3 mg/l, respectively.

Efficient operation of groundwater recharge projects requires a quality of reclaimed water which will maintain high infiltration rates for long periods of time. Low concentrations of suspended solids and organic matter minimize the rate of soil clogging which can determine the success of a groundwater recharge operation.

The proposed Health Department regulations specifically exclude chlorination for disinfection. This is a result of concern over the formation of potentially toxic chlorinated hydrocarbons in the water if chlorination is practiced. The Health Department believes that safe water can be achieved by (1) percolation through the soil, and (2) at least a year in transit to the nearest well, without the need for chemical disinfection. The Health Department also requires a quantity limit of not more than 50% of the water entering a groundwater basin at a spreading area during any 12-month period to be reclaimed water. This is to assure a minimum 50% dilution of reclaimed water at extraction from any point in the basin. It is hoped that the City would not be required to comply with the 50% dilution requirement at the point of spreading, if we can demonstrate the ability to comply with the intent of this section, i.e., show the ability to dilute with water from other wells or from other natural sources in the underground. If the City cannot be excused from this requirement, additional cost analysis would be required to identify the cost of this proposal.

Table 3.8 summarizes the water quality criteria of reclaimed water for replenishment by spreading. It is important to note that these criteria are intended to apply to municipal wastewaters and not to wastewater from high industrialized areas where toxic substances are of greater concern.

Groundwater Replenishment by Injection

Direct injection of reclaimed water into a subterranean aquifer used for domestic water supply requires more stringent health related water quality criteria than any other reclaimed water use. This is because no substantial subsurface treatment is assured to occur (as from percolation through soil during groundwater replenishment by spreading) and water quality limits would have to apply before injection.

The primary concerns for water quality criteria for direct injection involve various health, aesthetic, and operational considerations. From a health standpoint, the reclaimed water must meet all mandatory drinking water regulations and must have a very low organic content to insure safety. Esthetically, the water must be such that is does not cause the dissolving of soil minerals which may increase the hardness, TDS, iron, and manganese content. Finally, the water must be capable of being injected in the barrier without increasing the need for well redevelopment as a result of clogging.

Water Quality criteria were developed on the basis of these considerations. The State Department of Health Drinking Water Regulations are essentially the core of the requirements. Another set of criteria was developed from the Waste Discharge Requirements promulgated by the California Regional Water Quality Control Board Los Angeles Region for the Los Angeles Water Recycling Project – Playa del Rey. This project was proposed to supply reclaimed water to the West Coast Basin Barrier Project. Additional concerns for groundwater basin management for this project were reflected by the Central and West Basin Water Replenishment District. In addition, the County Flood Control District set a maximum suspended solids concentration of 5 mg/l to minimize the rate of increase of the injection head pressure.

The above-mentioned criteria are summarized in Table 3.8 to establish a reclaimed water quality requirement associated with a water acceptable for injection in the Barrier. The EPA has recently developed proposed regulations for underground injection under the Safe Drinking Water Act. Because these regulations are tentative and did not include specific water quality requirements, they were not included in the criteria presented here.

Industrial

Since much of the reclaimed water proposed for industrial use in the Los Angeles area is to be used for cooling purposes, discussion will be directed toward that particular use. If some other quality of water is desired by industry, it will be necessary for that industry to add additional treatment on their own.

Certain water quality requirements must be met before industry will accept the use of reclaimed water. There are five basic water quality requirements for cooling water. Such water should *not:*

1. Deposit scale;
2. Corrode the cooling system;
3. Encourage the growth of slime forming organisms;
4. Deteriorate wood in cooling towers (delignification); or
5. Require excessive amounts of blowdown.

Some of the important water quality parameters which determine the usability of reclaimed water for cooling purposes include orthophosphate, ammonia, suspended solids, hardness, alkalinity, pH, and total dissolved solids.

Industrial water quality criteria typically set a limiting concentration on phosphate as a means of controlling the scaling tendency of a makeup water. Scaling is usually caused by the deposition of calcium phosphate salts. Literature shows that the water quality criteria for cooling purposes typically limit the phosphate concentration to 1 – 2 mg/l. This very stringent requirement often dictates that most secondary effluent must be treated for phosphate removal via the use of lime, aluminum salts, or iron salts to insure that the water does not scale the heat exchanging surfaces and consequently cause loss of heat transfer efficiency.

A corrosive or aggressive water can also cause serious problems when used for cooling, in that the piping and equipment of the cooling system may become damaged. Organic materials in the water can lead to pitting and localized corrosion of metallic surfaces. Excessive concentrations of ammonia can corrode copper and copper. alloys. Low pH waters are also very corrosive. Thus, a balance between scale formation and corrosion must be reached for good operations.

The growth of microorganisms that may act as contributors to corrosion or as slime formers that foul the surfaces of cooling towers and piping is detrimental to operating efficiency. Control of suspended solids and proper disinfection usually eliminates these problems.

Delignification is mainly caused by the presence of sodium carbonate in the cooling water. It is recommended that the pH of cooling water be maintained between 6.5 – 7.5 for a more favorable carbonate-bicarbonate balance.

High total dissolved solids in the cooling water require an increase in the amount of blowdown from the cooling tower. A recent Contra Costa Water District Study determined that, as a result of high TDS, increased blowdown was required, and consequently, more water was required for the same amount of cooling. In addition, greater wastes were produced which entailed higher waste treatment costs to the user. Thus, the lower the TDS concentration, the higher the number of concentration cycles that can be achieved. This results in lower water consumption and lower cost to the user.

Where reclaimed water is used in industry, it is important to note that a dual water distribution system must be incorporated at the point of use which segregates the potable water from the reclaimed water supply. Extreme care is required along with the use of adequate backflow prevention devices (such as a reduced pressure principle backflow preventer) to protect the industrial user's drinking water supply and other in-plant water uses from possible cross-connections and contamination with reclaimed water.

Water quality criteria have been established for industrial use based on the above considerations, a review of literature, and surveys of various industries in the Los Angeles area who have the potential for using reclaimed water. These criteria are summarized in Table 3.8. It should be noted that the quality of water presented here may not be suitable to all industries but does represent a reasonable quality water which would be suitable for most of the surveyed uses.

Irrigation and Recreation

Regulations and standards for the use of reclaimed wastewater for irrigation and recreation are set forth by the California State Department of Health. Reclaimed water used as a source of supply for spray irrigation and non-restricted recreational impoundment is required to be an adequately disinfected, oxidized, coagulated, clarified, filtered wastewater. Adequate disinfection is achieved if the median number of coliform organisms does not exceed 2.2 per 100 milliliters and the number of coliform organisms does not exceed 23 per 100 milliliters in more than one sample within any 30-day period. Separate transmission lines for reclaimed and domestic water is required by the State Department of Health, and the Regulations Relating to Cross Connections from the California Administrative Code must be complied with.

General guidelines for acceptable water quality criteria for irrigation water were found in a report from the University of California, Cooperative Extension. Important constituent and criterion levels for irrigation waters are total dissolved solids, boron, chloride, sodium, and percent sodium (% Na).

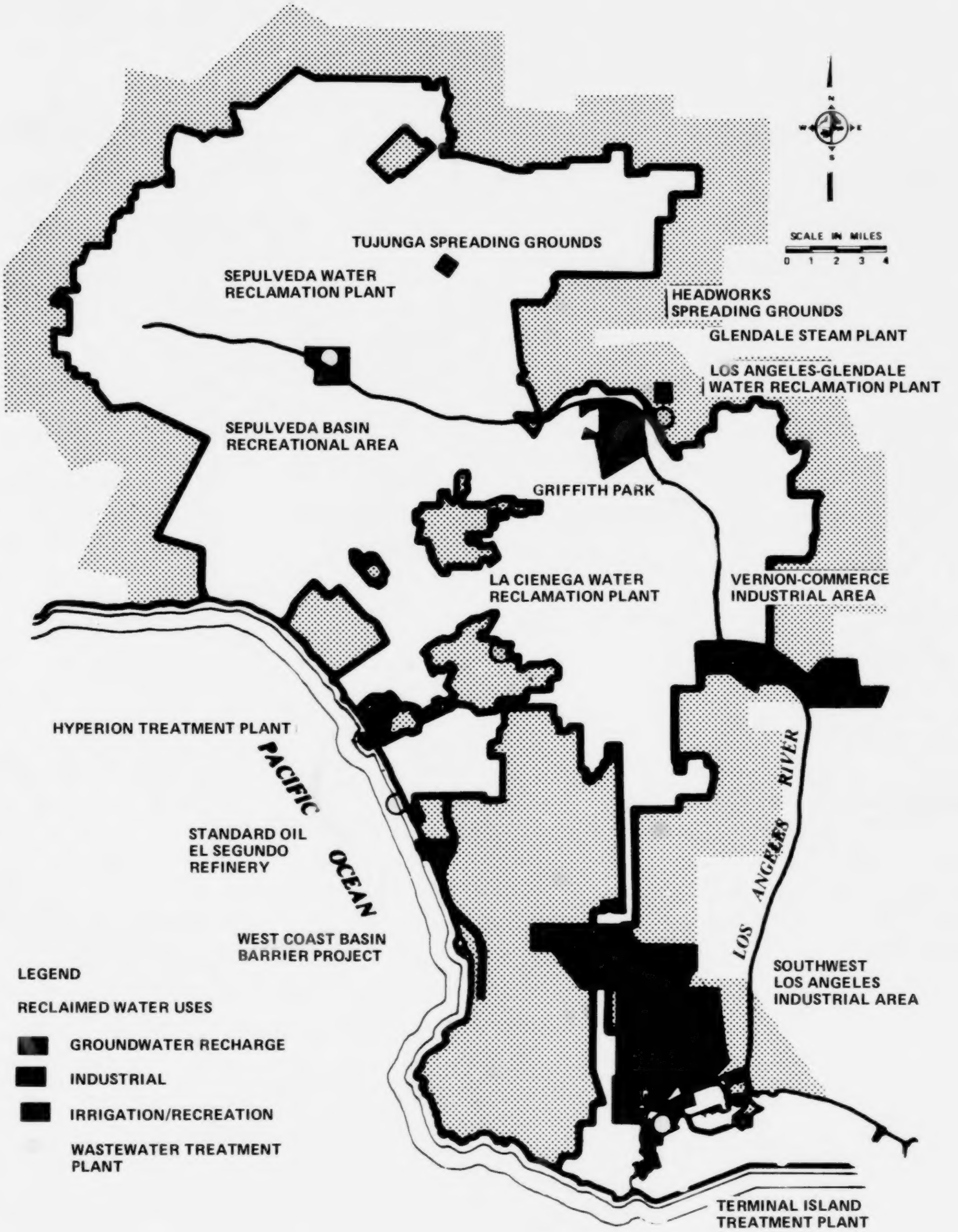

N
S
E
W
SCALE IN MILES
0 1 2 3 4
TUJUNGA SPREADING GROUNDS
SEPULVEDA WATER RECLAMATION PLANT
HEADWORKS SPREADING GROUNDS
GLENDALE STEAM PLANT
LOS ANGELES-GLENDALE WATER RECLAMATION PLANT
SEPULVEDA BASIN RECREATIONAL AREA
GRIFFITH PARK
LA CIENEGA WATER RECLAMATION PLANT
VERNON-COMMERCE INDUSTRIAL AREA
HYPERION TREATMENT PLANT
PACIFIC OCEAN
STANDARD OIL EL SEGUNDO REFINERY
WEST COAST BASIN BARRIER PROJECT
LOS ANGELES RIVER
SOUTHWEST LOS ANGELES INDUSTRIAL AREA
TERMINAL ISLAND TREATMENT PLANT
LEGEND
RECLAIMED WATER USES
GROUNDWATER RECHARGE
INDUSTRIAL
IRRIGATION/RECREATION
WASTEWATER TREATMENT PLANT
198P-428

Figure 3.5. Reclaimed water market areas.

TABLE 3.9

RECLAIMED WATER SERVICE AREAS

Location	Use	Flow (mgd)	Year Implemented
Griffith Park	Irrigation	5	1980
Glendale Steam Plant	Industrial	3	1980
Sepulveda Basin Recreation Area	Irrigation	9	1980
Headworks/Tujunga Spreading Grounds	Groundwater Replenishment	45	1985
Standard Oil Refinery – El Segundo	Industrial	8	1985
Southwest Los Angeles Industries	Industrial	52	1985
Vernon–Commerce Industries	Industrial	20	1985
West Coast Basin Barrier Project	Seawater Intrusion Barrier	35	1990
TOTAL		**177**	

Total dissolved solids (TDS) content represents total salts in the soil and is important from a physical and chemical standpoint. Critical levels of TDS (greater than 1000 mg/l for agriculture) in an irrigation water exerts an osmotic pressure which can limit the water uptake by plant roots. Levels of boron in excess of 1.0 mg/l may result in burning of plant leaves, chlorosis, and necrosis and can reduce crop yields. Chloride and sodium concentrations in excess of 100 and 120 mg/l, respectively, have caused significant yield reduction to crops in the Santa Barbara and Ventura Counties. The percent sodium (% Na) provides a measure of the relative alkali hazard of an irrigation water. Significant yield reduction of crops can result if the percentage exceeds 50%.

The above criteria for irrigation and recreation waters are summarized in Table 3.8.

3.3 RECLAIMED WATER SERVICE AREAS

An analysis was made of the various potential reclaimed water uses in terms of location, flow demand, and water quality. This resulted in a number of separate reclaimed water service areas. These service areas will be referred to in Chapter 4 to develop the costs of potential reclaimed water systems.

Some of the key points in developing the reclaimed water service areas should be noted before proceeding. First, all minor irrigation uses have been screened out of future cost analysis in this report, since the demands were questionable and the uses would probably be served from a larger industrial system. This could be done because the water quality criteria for irrigation and industrial purposes are generally similar. Second, the Carson–Torrance and Los Angeles Harbor Industrial areas have been combined to form the Southwest Los Angeles Industrial area. This was done because a distribution system feeding the Carson–Torrance area would need only minor extensions to serve the Harbor area demands. The Standard Oil Refinery in El Segundo was made a separate market as it could be supplied by either a separate system or in conjunction with a system serving the Southwest Los Angeles Industrial area. The Valley Steam Plant was screened out because there is some question as to the future existence of the plant whose economic life ends in 1984. Finally, only the first stage of irrigation use at Griffith Park was included since the remaining uses are in the conceptual stage and are contingent on the outcome of the current master planning studies at the park.

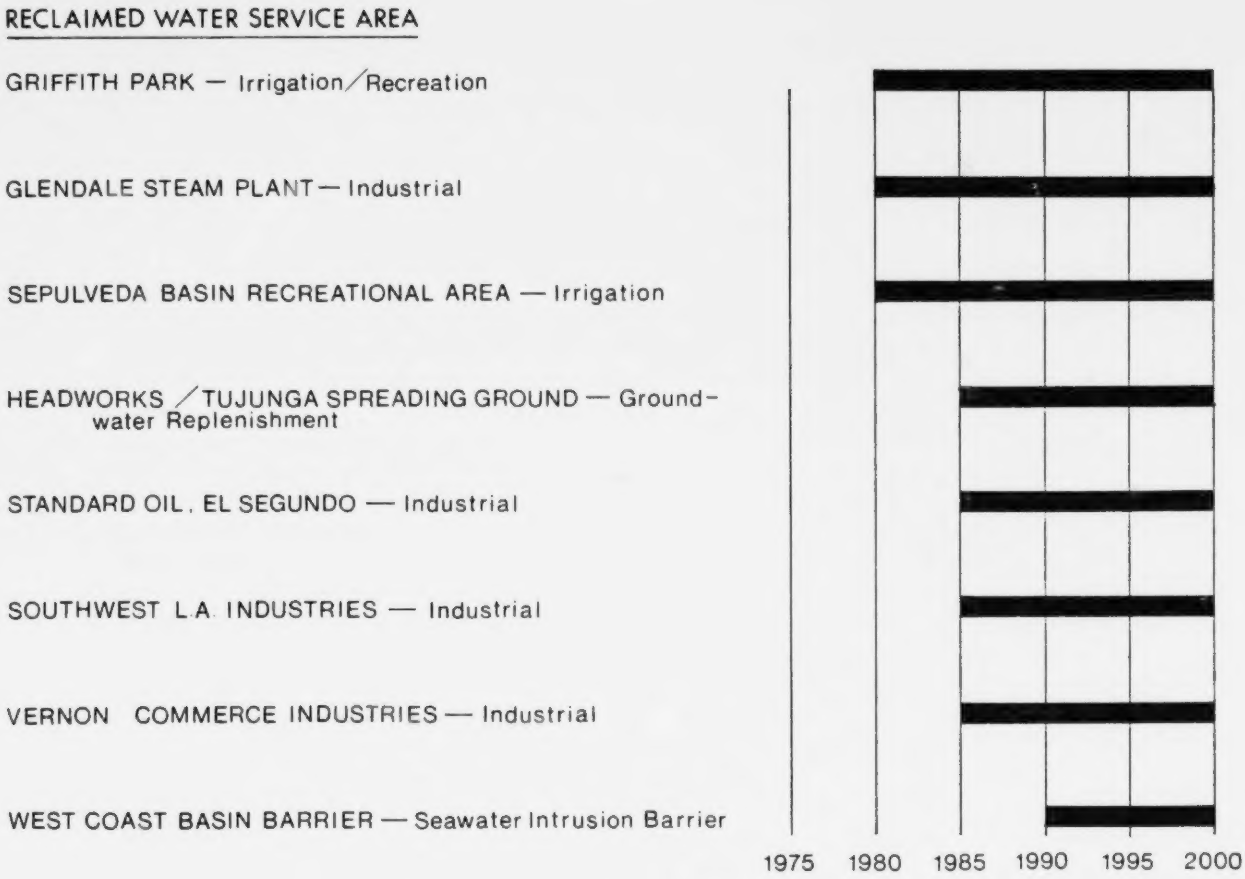
Based on these points, the following reclaimed water service areas have been defined. These are: Griffith Park – irrigation; Glendale Steam Plant – industrial; Sepulveda Basin Recreational Area – irrigation; Headworks and Tujunga Spreading Grounds – groundwater replenishment (surface spreading); Standard Oil El Segundo Refinery – industrial; Southwest Los Angeles Industries – industrial; Vernon–Commerce Industries – industrial; and West Coast Basin Barrier Project – seawater intrusion barrier supply (injection). These areas which are shown in Figure 3.5 have a total reclaimed water demand of 177 mgd as shown in Table 3.9. These service areas would potentially be supplied by separate reclaimed water distribution systems from local wastewater treatment plants.

3.4 IMPLEMENTATION SCHEDULE

For purposes of this report, an implementation schedule was prepared for each of the reclaimed water service areas. This schedule, which is shown in Figure 3.6, indicates when each service area might be expected to be operational to the nearest five years. This

figure 3.6

PROPOSED RECLAIMED WATER IMPLEMENTATION SCHEDULE



NOTE: The uses shown as being implemented in 1985 probably could not be started that soon, however, that date was chosen for analysis purposes reflecting the earliest time to start to clearly show the value of including the proposed La Cienega Water Reclamation Plant.

schedule takes into account the various contraints on the implementation of each of the uses for reclaimed water as well as the time for design and construction of the necessary facilities. Five-year periods were used to simplify the cost calculations presented in the next chapter.

In general, there are no particular constraints to the implementation of irrigation and recreational water supply systems for Griffith Park and the Sepulveda Basin Recreation Area. Plans are being prepared with construction anticipated to begin in 1978 to segregate the irrigation system in Griffith Park from the drinking water system so that reclaimed water can be used for irrigation. Although there are no similar activities at the Sepulveda Basin, it is estimated that construction would commence in 1980.

Industrial water systems have some constraints, however, that must be resolved before this use can be implemented. In general, there is a problem with the discharge of cooling tower blowdown or similar industrial wastes to receiving waters, as the salts have been concentrated during use and would exceed the discharge requirements. However, the overall waste load to the receiving water in pounds per day would be no different than if the reclaimed water were discharged without any reuse. This problem with regulations must be resolved before any significant reclamation for industrial use is implemented. It is estimated that this use will not be implemented until at least 1985.

An exception to this problem is the Glendale Steam Plant. A phosphate removal plant and pipeline are currently being constructed to supply reclaimed water for cooling tower makeup. This plant is estimated to be on-line in early 1978. For this report, costs will be based on a 1980 implementation date.

Groundwater recharge by spreading could be implemented as soon as water quality requirements are available. Since these requirements are in draft form and could be adopted in the near future, it is estimated that this use could be implemented by 1985, pending further analysis of the cost-effectiveness of this use. Implementation of the project by 1985 would require time for completion of a number of studies and design and construction of treatment and transmission facilities.

The use of reclaimed water to supply the West Coast Basin Barrier Project is currently constrained by both water quality and financial problems. The water quality problems stem from concerns by the State Department of Health over health-related factors which may require significant research and study to resolve. Once they are satisfied, the State Department of Health will set limiting water quality criteria. The financial problems stem from the need to conduct demonstration studies before a full-scale program is implemented and the limited funding available for these studies from either the agencies involved in the project or from grants. If policies relative to pricing of the health related problems could be resolved, reclaimed water would be used by 1990. There is significant risk in making either of these assumptions.

CHAPTER 4

ALTERNATIVE RECLAIMED WATER SYSTEMS

The purpose of this chapter is to develop costs for representative water distribution systems to provide reclaimed water to the major potential markets developed in Chapter 3 for use in evaluating the potential reclamation benefit of Wastewater Management Plan Alternatives B and E. Representative distribution systems for major users were designed to allow for future use by minor reclaimed water users not developed in this chapter. The significance of developing only representative systems is to minimize the amount of cost estimating while still identifying the significant monetary costs, energy requirements and land requirements. This level of data was considered sufficient for evaluating the differences between Wastewater Management Plan Alternatives B and E. Costs, energy and land requirements are developed for six unique levels of reclaimed water demand providing a test of the sensitivity of these costs to variation in market demand.

4.1 RECLAIMED WATER SYSTEM REQUIREMENTS

Market Demand

Sensitivity testing is necessary because the future of water reclamation in the Los Angeles area is not clear at this time. Two markets for reclaimed water were tested for sensitivity to Wastewater Management Plan Alternative B compared to E. These were the markets for industrial water and seawater intrusion barrier uses. The other reclaimed water uses are presented for comparative purposes only, and not tested for sensitivity, since they do not impact the decision on the wastewater management plan alternatives.

Several factors which may act as a deterrent to the development of markets for reclaimed water as a water source are presented in Table 4.1. Consideration of these deterrent factors has resulted in sensitivity testing of industrial reuse at three levels – 30, 52, and 72 mgd. These three levels of industrial use include the full range of anticipated developable markets in the Southwest Los Angeles Industrial service area (moderate 30 mgd, maximum 52 mgd), and a rough estimate of the potential market in the Vernon–Commerce Industrial Service Area (20 mgd, additional).

Development of reclaimed water as a source for the seawater intrusion barrier (35 mgd) is sensitive to the potential impacts on the health of consumers using the inland groundwater basin and to the financial feasibility of the project.

The reclaimed water supply requirements which were identified for analysis in Chapter 3 have thus been analyzed identifying those requiring sensitivity testing.

Water Quality

The water quality requirements for reclaimed water uses have been identified in Chapter 3. The quality of wastewater effluents available from each treatment plant under Wastewater Management Plan Alternatives B and E has been identified in Chapter 2. Comparison of the reclaimed water quality requirements with the quality of the available wastewater effluents reveals deficiencies which require additional treatment. This treatment would be provided in the proximity of the wastewater sources.

Table 4.1

DETERRENT FACTORS TO CITY OF LOS ANGELES SERVING RECLAIMED WATER TO INDUSTRY

1. Many of the uses could be served as readily from treatment plants of the County Sanitation Districts of Los Angeles.

2. The functional life of the industries may not be assured beyond the year 2000, thus limiting justification for major pipeline and treatment plant construction.

3. Industrial in-plant recycling of water may be a more cost-effective alternative water supply than using reclaimed water.

4. The existing source of supply may be the cheapest and most cost-effective source of water supply for industry.

5. City of Los Angeles Charter limitations may exist regarding terms of contractual agreements and water service outside the City.

A preliminary comparison of treatment plant effluent quality with proposed reclaimed water use quality requirements indicated there were generally no major water quality problems which would prevent the various uses from being supplied by adjacent treatment plants, with additional treatment in some cases. However, the Los Angeles-Glendale Water Reclamation Plant could not supply groundwater replenishment because substantial industrial waste flows exist which is not allowed by the State Department of Health for this use. The quality deficiencies are described by use from each treatment plant in Table 4.2.

Quality control required to provide a safe, reliable reclaimed water supply for each use can be accomplished by a combination of wastewater treatment plant modifications and the addition of advanced wastewater treatment (AWT). The wastewater treatment plant modifications were chosen to maximize segregation of unreclaimable wastes followed by maximizing biological treatment and minimizing energy requirements. Hence, the modifications presented in Table 4.3 were required in various degrees at the wastewater treatment plants indicated. AWT processes were chosen to provide assurance of water quality control given the wastewater treatment plant effluent as modified above. These AWT processes are identified by reclaimed water use in Table 4.4

The treatment improvements and modifications for water quality control described in this report are used for cost, energy and land requirement analysis only. Future refinement of the treatment processes and development of new technology should be considered in order to provide savings in investment along with added reliability.

Distribution Systems

The requirements for each distribution system were developed using projected peak flow demands and service pressures desired by each user. A major consideration involved

TABLE 4.2

RECLAIMED WATER QUALITY DEFICIENCIES OF WASTEWATER TREATMENT PLANT EFFLUENT

	Source	Criteria of Use[2]	Deficiency	Source	Criteria of Use[2]	Deficiency	Source	Criteria of Use[2]	Deficiency	Source	Criteria of Use[2]		Deficiency	
Water Quality Parameter[1]	Sepulveda WRP Effluent	Groundwater Recharge (Spreading)	Quality Control Needed[3]	LA/Glendale WRP Effluent	Glendale Power Plant Cooling	Quality Control Needed[3]	La Cienega WRP Effluent	Industrial (Cooling Water)	Quality Control Needed[3]	Hyperion Treatment Plant Effluent	Industrial (Cooling Water)	Groundwater Injection	Quality Control Needed[3]	
TDS	500	700		500	700		650	700		750	700	700	Marginal	Marginal
Suspended Solids	<5	–		<5	5		<5	5		25–30	5	5	Yes	Yes
BOD	5	–		5	–		5	–		25–30	–	–		
COD	25	5	Yes	25	40		25	40		70	40	15	Yes	Yes
NH_4–N	10	–		10	1.0	Yes	10	1.0	Yes	12	1.0	–	Yes	
TKN	12	6	Yes	12	–		12	–		25	–	6		Yes
(NO_2+NO_3)-N	0	10		0	10		0	10		0	10	7–10	Yes	
Ortho-Phosphate	10	–		10	2	Yes	10	2	Yes	25	2	–	Yes	
pH (units)	7.4	6.5–9.0		7.4	6.5–7.5		7.4	6.5–7.5		6.7	6.5–7.5	6.5–9.0		
Total Hardness $CaCO_3$	95	–		95	130		130	130	Marginal	180	130	–	Yes	
Alkalinity – $CaCO_3$	120	–		120	20[4]		165	20[4]		175	20[4]	–		
Type of Discharge Requirement Applied	Stream			Stream			Stream			Ocean				

1. All concentrations expressed in mg/l unless otherwise noted and represent maximum concentrations.
2. Criteria based on references 3.2, 3.6, 3.7, 3.9–3.12.
3. Requires In-plant modification or advanced treatment for additional removal of this parameter.
4. This criteria is desired to be met but not mandatory.

TABLE 4.3

PROPOSED WASTEWATER TREATMENT PLANT MODIFICATIONS

WASTEWATER TREATMENT PLANT	MODIFICATION TO PROVIDE A RECLAIMABLE ELEMENT
Sepulveda WRP	Provide nitrification by adding reactors and clarifiers. Transport sludge to Hyperion sludge facilities via separate force main, thus reducing heavy metals in Hyperion effluent.
LA–Glendale WRP	None
La Cienega WRP	Provide nitrification by adding reactors and clarifiers. Transport sludge to Hyperion sludge facilities via separate force main, thus reducing heavy metals in Hyperion effluent.
Hyperion TP	Segregate high TDS influent sewer. Provide nitrification by converting existing secondary reactors and clarifiers and/or by adding new reactors and clarifiers. Convert high-rate pure-oxygen secondary system to fine bubble process.

TABLE 4.4

PROPOSED ADVANCED WASTEWATER TREATMENT

RECLAIMED WATER USE	ADVANCED WASTEWATER TREATMENT PROCESSES TO ASSURE QUALITY REQUIREMENT OF USE
Groundwater Recharge – Headworks and and Tujunga Spreading Grounds	Carbon adsorption for organics reduction Denitrification for nitrate reduction
Power Plant Cooling – City of Glendale	Alum coagulation and filtration for phosphate reduction Rechlorination for disinfection
Industrial Cooling Tower and Process Use – Vernon Industries, Southwest Los Angeles Industries and Standard Oil Refinery	Lime coagulation and filtration for phosphate reduction* Chlorination for disinfection
Seawater Intrusion Barrier – West Coast Basin Barrier Project	Lime coagulation and filtration for suspended solids and virus reduction Carbon adsorption for organics reduction Breakpoint chlorination for assured virus removal (ozone may be substituted at a similar cost)

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* Required only at the Hyperion Treatment Plant since the secondary system is a high-rate process which is not expected to provide for phosphate uptake, while the La Cienega Water Reclamation Plant can provide for such.

TABLE 4.5

WASTEWATER TREATMENT PLANTS SERVING RECLAIMED WATER USES

Treatment Plants Serving Each Use are Identified for Wastewater Management Plan Alternatives B and E

Wastewater Treatment Plant	RECLAIMED WATER USE	
	Alternative B	Alternative E
Sepulveda WRP	Irrigation–Sepulveda Basin Recreational Area	Same
	Groundwater Recharge–Headworks and Tujunga Spreading Grounds	Same
LA–Glendale WRP	Power Plant Cooling–City of Glendale	Same
	Irrigation–Griffith Park	Same
La Cienega WRP	Not Applicable	Industrial–Vernon Industries, SWLA Industries
Hyperion TP	Industrial–Standard Oil Refinery, SWLA Industries, Vernon Industries	Standard Oil Refinery
	Seawater Intrusion Barrier–West Coast Basin Barrier Project	Same

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deciding which wastewater treatment plant would serve which potentially reclaimed water market. Table 4.5 provides information on the uses from each plant which meet criteria for location and effluent quality.

4.2 MONETARY COSTS TO PROVIDE RECLAIMED WATER

The monetary cost of providing reclaimed water to the potential markets presented in Table 4.5 are developed in this section. The sensitivity of the reclaimed water costs for selected industrial and seawater intrusion barrier uses to a change from Wastewater Management Plan Alternative B to E is also developed and presented in this section. These sensitivity results are intended to summarize the monetary impact of water reclamation on the alternative wastewater management plans now under consideration.

The results of the monetary cost analysis are graphically presented in Figure 4.1. In this figure, the total costs of providing reclaimed water to various uses via six alternative reclaimed water systems during the period 1980–2000 is compared to Wastewater Management Plan Alternatives B–4, E–1, and E–2.

The results of the sensitivity analysis are presented in Table 4.6. This table presents the results of increasing industrial demands from zero to 72 mgd and the Barrier use from zero to 35 mgd. Providing this maximum supply increases monetary costs in the range of \$55 to \$69 million (present worth in 1975 dollars) for Wastewater Management Plan Alternative B over Alternative E.

The total costs of providing reclaimed water as presented in this chapter were obtained from cost curves in an EPA report, and other cost curves. The EPA report recommends that the cost curve data be used only for comparing alternatives; detailed cost estimates should be prepared for final analysis. These estimates were the only costs determined in this report, and thus more detailed estimates will be needed before firm conclusions can be made.

The costs presented as totals are the 1975 *present worth* of the *total* expenditures to be made (Capital and O&M) to provide reclaimed water during the planning period 1975 through 2000. The salvage value at the end of the planning period was not estimated in this chapter. Since the purpose was limited to defining the impact of wastewater management plan alternatives on expenditures for water reclamation, refinement was not considered necessary. A breakdown of total and unit capital, and operation and maintenance costs is presented in Table 4.7 for each reclaimed water system alternative. In Table 4.8 the total cost is presented by type of use for the six levels of total use.

The general procedure and references used to develop the total costs of providing reclaimed water are identified below. The assumptions used for estimating the costs are presented in Table 4.9.

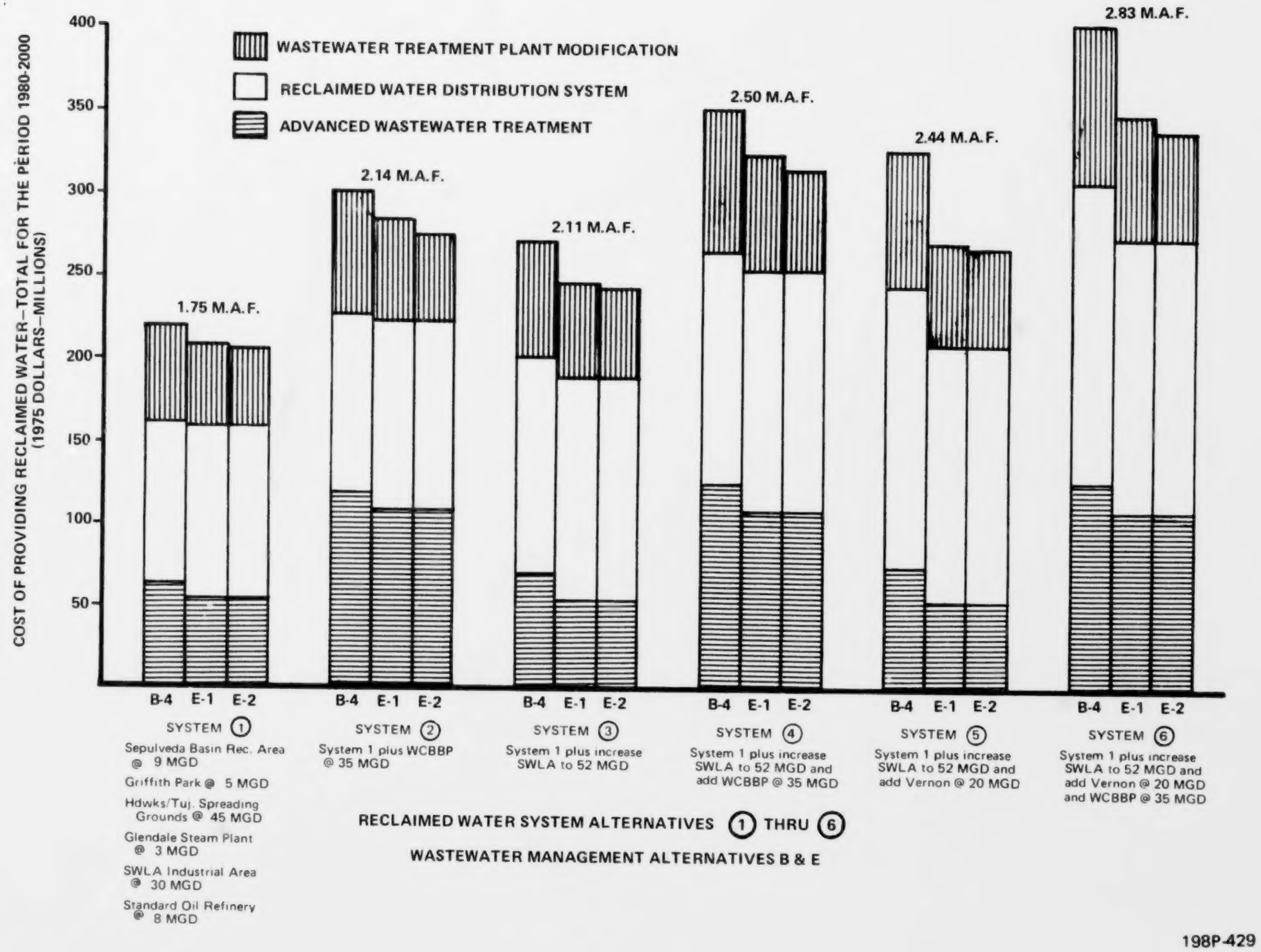

Figure 4.1. Total cost of alternative reclaimed water systems, 1980 through 2000.

TABLE 4.6

MONETARY COST IMPACT OF ALTERNATIVE WASTEWATER MANAGEMENT PLANS ON WATER RECLAMATION

RECLAIMED WATER USE	CHANGE IN SYSTEM	Increased Monetary Cost of Providing Reclaimed Water to Use with Wastewater Management Plan Alternative B over E *(Present Worth in Millions 1975 Dollars for the Period 1980 thru 2000)*
Industrial – *Southwest Los Angeles Industries*	*Increased Demand from 0 to 30 mgd*	13 – 15
Industrial – *Southwest Los Angeles Industries*	*Increased Demand from 30 to 52 mgd*	12
Industrial – *Vernon Industries*	*Increased Demand from 0 to 20 mgd*	22 – 29
Seawater Intrusion Barrier – *West Coast Basin Barrier Project*	*Increased Demand from 0 to 35 mgd*	8 – 13

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Cost Analysis Procedure

Task	Reference
1. The major potential reclaimed water markets were identified and indexed with the wastewater treatment plant which could be the source to such use (taken from Table 4.5). Market identification numbers were given to combinations of reclaimed water markets for later development of the six sensitivity testing groupings.	Table 4.10 Reclaimed Water Market Identification
2. The components of cost which together make up the total costs to provide reclaimed water were developed. These components were separated in the cost analysis since each required unique cost considerations for the 13 markets identified in Table 4.10.	Figure 4.2 Reclaimed Water System Cost Components
3. The City of Los Angeles wastewater treatment plants have unique design options which differ between Wastewater Management Plan Alternatives B and E. These different design options are important in the consideration of the cost of providing reclaimed water.	Table 4.11 Wastewater Management Plan Alternatives
4. Figure 4.2 indicates the first cost component to be developed is that for modification of each wastewater treatment plant in order to provide a reclaimable effluent. Through coordination with Department of Public Works staff, the appropriate modifications for each reclaimed water market were developed. These modifications are dependent on the wastewater management plan alternative chosen. This dependence is also presented comparing the modification requirements of Alternatives B-4, E-1 and E-2 with each of the 13 reclaimed water markets identified in Table 4.10.	Table 4.12 Wastewater Treatment Plant Modification Requirements
5. Figure 4.2 indicates the second cost component to be developed is advanced wastewater treatment requirements. This treatment is required to assure quality control of the water served to each reclaimed water market as identified in Table 4.4. The specific treatment required for each of the 13 reclaimed water markets identified in Table 4.10 is developed.	Table 4.13 Advanced Wastewater Treatment Requirements
6. Figure 4.2 indicates the final cost component to be developed is the distribution system requirements to serve the treated wastewater to each reclaimed water market. These distribution systems vary with wastewater management plan alternatives due to the location of the wastewater treatment plants. A complete distribution system is developed and shown to functionally link the treatment plants with all potential reclaimed water uses. A separate distribution system is shown for Wastewater Management Plan Alternatives B and E due to the option of the La Cienega Water Reclamation Plant being included in E and not in B.	Figures 4.3, 4.4 Distribution Systems for Major Reclaimed Water Uses

Task	Reference
7. Reclaimed water system alternatives were then formed from the 13 markets identified in Table 4.10 combining the markets into total systems for each wastewater management plan. Six unique systems were identified to test the sensitivity of the cost impact on the size of the industrial market and on the barrier use.	Table 4.14 Reclaimed Water System Alternative

4.3 ENERGY REQUIREMENTS TO PROVIDE RECLAIMED WATER

The energy demand for water reclamation has been demonstrated to be sensitive to the Wastewater Management Plan Alternatives and the ultimate level of reclamation development. The major reason for this sensitivity is that the DWP has asked that the effluent from Alternative E meet (more stringent) water quality criteria than that for Alternative B.

Table 4.15, which presents this sensitivity, indicates that an incremental energy demand of 1.8 billion kilowatt-hours (equivalent to 3.0 million barrels of oil) would be required to implement Wastewater Management Plan Alternative B over Alternative E. This increment is determined by totaling the increased energy demand figures in Table 4.15 for a maximum industrial reclaimed water use of 72 mgd.

The estimate made of energy demands for the reclaimed water alternative systems takes into account both treatment and distribution energy requirements. Typical direct and indirect energy use values for treatment process operations were obtained from Messrs. Robert M. Hagan and Edwin B. Roberts' report, *Energy Requirements of Alternatives in Water Supply, Use and Conservation.* Values were applied to the thirteen system alternatives which specify various quantities and uses of reclaimed water from the four treatment plant locations. The amount of energy needed to construct treatment process facilities was excluded from the total energy demand for each alternative; however, the totals do reflect the differing levels of tertiary treatment requirements.

Distribution energy demands are limited to the direct horsepower (energy) requirements for pumping reclaimed water to the points of use under evaluation. Direct and indirect energy requirements for treatment were then combined with the direct energy requirements for distribution. These values were assigned to the six alternative reclaimed water systems that have been developed. Table 4.16 lists these energy requirements for the six systems and compares the energy demand between Wastewater Management Plan Alternatives B and E.

4.4 LAND REQUIREMENTS AND AVAILABILITY FOR RECLAIMED WATER SYSTEMS

The requirements and availability of land for water reclamation are sensitive to the wastewater management plan alternatives, and to the level of reclamation ultimately developed. A scarcity of open and available land in the vicinity of the Hyperion Treatment Plant may be the most substantial constraint to development of water reclamation at that facility. The Sepulveda Water Reclamation Plant will have enough land to meet theoretical needs for water reclamation. The Los Angeles–Glendale WRP has limited land available for additional treatment for reclamation unless the planned plant expansion of the final 10 mgd does not occur. The land proposed for a La Cienega WRP is not presently owned by the City thus a determination of available land cannot be made for this plant. The land is presently in high intensity commercial use with high value residential property surrounding it making procurement difficult. The Hyperion Treatment Plant is deficient in land for water reclamation by from 4 to 29 acres in the case of Wastewater Management Plan Alternative B while it is not deficient in Alternative E. This indicates a sensitivity of Alternative B to land availability if ultimate development of water reclamation were to occur.

Land requirements for advanced wastewater treatment were taken from EPA publication *A Guide to the Selection of Cost-Effective Wastewater Treatment Systems* – EPA 430/9-75-002, July 1975. The information was put in graphic form and is presented as Figure 4.5. Land requirements were estimated for each process and accumulated in a manner similar to that used in the monetary cost analysis. The results are presented by use; i.e., each reclaimed water use is identified with the land requirements based on the wastewater management plan alternative.

Land requirements for wastewater treatment plant modification, specifically for nitrification, were estimated by Department of Public Works staff based on actual design layouts of the secondary system at the Los Angeles–Glendale Water Reclamation Plant assuming equivalent unit land requirements for a nitrification system. Note that these land requirements are less than those estimated from the EPA report above.

The total land requirements for nitrification and advanced water treatment for each proposed reclaimed water use is presented in Table 4.17. The requirements are presented in this table by alternative wastewater management plan since treatment requirements vary for each plan, and since, in the case of Alternative E-2, no additional facilities are needed to provide nitrification requiring no additional land.

Information on the land availability at each wastewater treatment plant was provided by Department of Public Works staff. Land was specifically set aside at the Sepulveda and La Cienega Water Reclamation Plant sites for water reclamation, (see Figures 4.6 and 4.7, respectively).

Land available for reclamation at the Hyperion Treatment Plant has not been set aside in Alternative B-4; to do so would delay implementation and increase construction costs. Figure 4.8 presents the current conceptual layout of the facilities required on Hyperion Treatment Plant property to provide secondary treatment and sludge disposal. Figure 4.9 presents a revised conceptual layout of required facilities on Hyperion Treatment Plant property with the maximum land made available for reclamation by redesign and relocation of proposed new facilities.

Land available for reclamation at the Hyperion Treatment Plant in Alternatives E-1 and E-2 is shown in Figures 4.10 and 4.11, respectively. In both of these alternatives, maximum land was provided to accommodate reclamation.

Any land not already provided for water reclamation on the Hyperion Treatment Plant property would be difficult to obtain. Options would include Department of Airports property in the City of Los Angeles and inland property in adjoining cities, possibly near the locations of use. To date the Department of Airports has not been receptive to proposals to use their land for anything other than air travel. No firm optional sites are proposed, and thus, such land needs are shown as deficiencies in this analysis.

The total availability of land at each wastewater treatment plant for water reclamation is presented in Table 4.18. The availability is presented by wastewater management plan alternative; and, for Alternative B-4, it is presented both with and without redesign and relocation of proposed new facilities. Note: It must be remembered that the City does not now own any land at the proposed La Cienega WRP site. It is estimated that procurement will be difficult at best.

Comparison of land availability with land requirements has revealed land deficiencies only at the Hyperion Treatment Plant for various proposed reclaimed water uses. These land deficiencies are presented in Table 4.19.

TABLE 4.7

COST BREAKDOWN FOR ALTERNATIVE RECLAIMED WATER SYSTEMS – 1980 THRU 2000
CAPITAL, OPERATIONS AND MAINTENANCE, TOTAL
TOTAL AND UNIT COSTS – 1975 DOLLARS

ALTERNATIVE RECLAIMED WATER SYSTEM NO. [3]	TOTAL QUANTITY RECLAIMED IN THE PERIOD 1980–2000 (millions acre-ft)	COST OF PROVIDING RECLAIMED WATER FOR THE PERIOD 1980–2000 [1] TOTAL COST IN MILLIONS DOLLARS/(UNIT COST IN DOLLARS PER ACRE–FOOT) – 1975 DOLLARS								
		CAPITAL* [2]			OPERATIONS AND MAINTENANCE			TOTAL* [2]		
		B–4	E–1	E–2	B–4	E–1	E–2	B–4	E–1	E–2
1	1.75	125.1	121.9	121.9	96.2	86.2	84.5	221.3	208.1	206.4
		(71.5)	(69.6)	(69.6)	(54.9)	(49.2)	(48.2)	(126.4)	(113.9)	(117.9)
2	2.14	165.5	161.7	156.4	135.8	123.4	119.8	301.3	285.1	276.3
		(77.3)	(73.0)	(75.5)	(63.4)	(57.6)	(55.9)	(140.7)	(133.2)	(129.1)
3	2.11	146.1	143.0	143.0	125.3	103.3	101.6	271.4	246.3	244.6
		(69.2)	(67.7)	(67.7)	(59.3)	(48.9)	(48.1)	(128.6)	(116.7)	(115.9)
4	2.50	186.3	182.8	177.5	164.6	140.5	137.0	350.9	323.3	314.5
		(74.5)	(73.1)	(71.0)	(65.8)	(56.2)	(54.8)	(140.3)	(129.3)	(125.3)
5	2.44	184.8	159.9	159.9	141.5	110.4	108.7	326.3	270.3	268.6
		(75.7)	(65.5)	(65.5)	(57.9)	(45.2)	(44.5)	(133.7)	(110.7)	(110.0)
6	2.83	221.6	199.7	194.4	180.6	147.6	144.1	402.2	347.3	338.5
		(78.3)	(70.5)	(68.6)	(63.8)	(52.1)	(50.9)	(142.1)	(122.7)	(119.6)

NOTES:

[1] Costs shown do not include the cost of wastewater treatment for disposal. See Table VIII–23 of the Facilities Plan for this data.

[2] Unit costs for capital and total are not representative of costs to be considered in "price" comparisons since capital has not been amortized in the planning period or given salvage value at the end of the planning period. Unit costs indicated reflect only 10 to 15 year lives for full repayment in 1975 dollars.

[3] See Figure 4.1 for identification of water system alternatives.

TABLE 4 8

COST BREAKDOWN FOR ALTERNATIVE RECLAIMED WATER SYSTEMS – 1980 thru 2000

ADVANCED WASTEWATER TREATMENT, DISTRIBUTION SYSTEM, WASTEWATER TREATMENT PLANT MODIFICATION

TOTAL COSTS, CAPITAL PLUS OPERATIONS AND MAINTENANCE – 1975 DOLLARS

	RECLAIMED WATER SYSTEM									COST OF PROVIDING RECLAIMED WATER FOR THE PERIOD 1980–2000								
	FLOW FOR EACH USE (Millions Acre-feet for the period beginning 1980–2000)																	
	IRRIGATION		GWR	PPC		INDUSTRIAL		SWB					WASTEWATER TREATMENT PLANT MODIFICATION			TOTAL		
ALT. NO.	SBRA	Griff. Pk.	HSG/TSG	Glendale	Vernon	SWLA	Std. Oil	WCBBP	TOTAL	WW ALT.	Advanced Wastewater Treatment	Distribution System	B–4	E–1	E–2	B–4	E–1	E–2
1	0.18	0.11	0.76	0.07		0.50	0.13		1.75	B	63.6	98.4	59.3	50.0	48.3	221.3	208.1	206.4
										E	53.4	104.7						
2	0.18	0.11	0.76	0.07		0.50	0.13	0.39	2.14	B	118.9	108.1	74.3	62.1	53.3	301.1	285.1	276.3
										E	108.5	114.5						
3	0.18	0.11	0.76	0.07		0.86	0.13		2.11	B	69.9	131.3	70.2	56.4	54.7	271.4	246.3	244.6
										E	53.4	136.5						
4	0.18	0.11	0.76	0.07		0.86	0.13	0.39	2.50	B	124.5	141.0	85.4	68.5	59.7	350.9	323.3	314.5
										E	108.5	146.3						
5	0.18	0.11	0.76	0.07	0.33	0.86	0.13		2.44	B	74.9	170.6	80.8	61.3	59.6	326.3	270.3	268.6
										E	53.4	155.6						
6	0.18	0.11	0.76	0.07	0.33	0.86	0.13	0.39	2.83	B	126.6	180.3	95.3	73.4	64.6	402.2	347.3	338.5
										E	108.5	165.4						

LEGEND:

GWR – Groundwater Recharge
PPC – Power Plant Cooling
SWB – Seawater Intrusion Barrier
SBRA – Sepulveda Basin Recreational Area

HSG – Headworks Spreading Grounds
TSG – Tujunga Spreading Grounds
SWLA – Southwest Los Angeles Industries
WCBBP – West Coast Basin Barrier Project

B–4 Wastewater Management Plan Alternative referring to 307 mgd secondary treatment at Hyperion without flexibility to provide reclaimable effluent.

E–1 Wastewater Management Plan Alternative referring to 232 mgd secondary treatment at Hyperion with a reclaimable effluent.

E–2 Wastewater Management Plan Alternative referring to 307 mgd secondary treatment at Hyperion with flexibility to convert to 232 mgd and provide a reclaimable effluent.

NOTE: The costs shown do not include the cost of wastewater treatment for disposal.

TABLE 4.9

ASSUMPTIONS FOR ESTIMATING COST OF PROVIDING RECLAIMED WATER BY COMPONENT

Wastewater Treatment Plant Modifications

1. Cost Estimates by C.J. Brogan, Wastewater Systems Engineering Division, Department of Public Works, City of Los Angeles, based on bid prices of City of Los Angeles facilities under construction with adjustments based on available literature.

Advanced Wastewater Treatment

1. Cost Estimates based on data presented in EPA report EPA–430/9 – 75-002, "A Guide to the Selection of Cost-Effective Wastewater Treatment Systems" with an updating to 1975 (ENR 2100) and without further modification of the assumptions based in that report.

Distribution System

1. Pipeline network lengths are scaled from surface street maps of the area along routes estimated to be feasible to locate with minimal traffic disruption.
2. Pipeline networks diameter of pipe based on economic pipe size formula $d = 6 (Q)^{1/2}$ ("d" is diameter in inches, "Q" is the peak flow in cubic feet per second).
3. Pipeline costs estimated at $4.80 per inch diameter per foot in length, including installation and repavement.
4. System pumping requirements based on headloss in pipeline with "C" value of 140 (Hazen-Williams), differential elevation from USGS maps, delivery pressure of 80 psi for all uses except groundwater recharge by spreading (0 psi).
5. Pumping station efficiencies at 85% each for both the pumps and the motors. Note: This would be much too high if the use was variable throughout any 24-hour period and thus was assumed to be equivalent for the period. Use was assumed constant.
6. Pumping station facilities capital costs based on the equation below by Hazen and Sawyer Engineers (reference: Draft EIS/EIR JOS Facilities Plan for the Sanitation Districts of Los Angeles, County, Appendix L) where ENR = 2000 and cost equals the cost of *operating* pumps, enclosure, instrumentation, engineering, and contingencies.

$$\text{Cost} = 5.0(Q)^{0.83}(N)^{0.65} + 62(Q)^{0.83}$$

The flow "Q" is in gallons per minute and the head "H" is the total pumping head in feet. Total *installed* pumping station costs is determined by direct relationship of the installed to the operating pumps with one spare as the criteria with the number of operating pumps a function of the horsepower requirements.

TABLE 4.9 (Continued)

7. Annual pumping station operation and maintenance costs, less power, are determined from DWP "Pumping Station M & O Expense, Less Power, 1970–75" curve with an updating factor of 1.5.

8. Annual pumping station power expense estimated from total operating horsepower requirements at an electrical energy price of \$.03 per kilowatt hour.

9. Reclaimed water spread for groundwater recharge, extraction and distribution to domestic customers in DWP service area; recharge costs and extraction costs for amortized capital plus operations and maintenance costs at \$10 per acre foot each (total \$20 per acre foot), distribution at the cost of electrical energy (\$0.03/kwh). Note: This assumes use of existing wells. If new wells must be constructed or (as should be done) some capital was charged against this use, the cost would be higher.

10. Reclaimed water served to Griffith Park and Sepulveda Basin Recreational Area for irrigation costs of additional system improvements from the mainline for the irrigation system needed to convert the existing system to a separate system from a potable water system based on a preliminary report by Keith and Associates for the Department of Recreation and Parks, prepared late 1976. Extra annual operations and maintenance costs for monitoring and supervision to provide needed reliability and safety at 10 percent of capital costs.

Total Present Worth

1. The present worth of all costs is determined by the summation of capital costs plus the annual cost times the number of years in operation. The rate of inflation and rate of return are assumed to be equivalent for the period.

TABLE 4.10

RECLAIMED WATER MARKET IDENTIFICATION

Comparison of Major Potential Reclaimed Water Uses in the Los Angeles Area with the LA City Wastewater Treatment Plants Which Could Potentially Serve Such Uses

		MAJOR RECLAIMED WATER USES (1980–2000)								
		1980					1985			1990
Wastewater Treatment Plant	Market ID NO.	Griffith Pk. Irrigation (5 mgd)	City of Glendale Power Plant Cooling (3 mgd)	Sepulveda Basin Recreational Area (9 mgd)	Standard Oil El Segundo Refinery (8 mgd)	Southwest Los Angeles Industrial Area (30 mgd)	Southwest Los Angeles Industrial Area (51/52 mgd)	Vernon Commerce Industrial Area (20 mgd)	Headworks and Tujunga Spreading Grounds (45 mgd)	West Coast Basin Barrier Project (35 mgd)
Sepulveda WRP	1			●					●	
LA–Glendale WRP	2	●	●							
La Cienega WRP	3					●				
	4						●			
	5						●	●		
Hyperion TP	6				●					
	7				●	●				
	8				●	●				●
	9				●		●			
	10				●		●	●		
	11				●		●	●		●
	12				●		●			●
	13				●					●

For comparison of Markets, the following are equivalent:

Market	Market
3+6	7
4+6	9
5+6	10
3+13	8
4+13	12
5+13	11

TABLE 4.11

WASTEWATER MANAGEMENT PLAN ALTERNATIVES

Identification of the Key Design Options to be Implemented with each LA City Wastewater Treatment Plant for Wastewater Management Plan Alternatives B and E

WASTEWATER TREATMENT PLANT	Design Option No.	WASTEWATER TREATMENT PLANT CAPACITY			COMMENTS	WASTEWATER MANAGEMENT PLAN ALTERNATIVE		
		Date of Implementation	Flow (mgd)[1]	Flow Pattern		B–4	E–1	E–2
Sepulveda WRP	1	1980 1985	40 70	Diurnal Diurnal	Treatment plant sludge is returned to sewer system.	•		
	2	1980 1985	40 70	Diurnal Diurnal	Treatment plant sludge is pumped by separate line to Hyperion TP.		•	•
LA–Glendale WRP	1	1977 1993	20 30	Constant Constant	Treatment plant sludge is returned to sewer system.	•	•	•
La Cienega WRP	1	1985	75	Constant	Treatment plant sludge is pumped by separate line to Hyperion TP.		•	•
	2				Plant not built.	•		
Hyperion TP	1	1980	307	Diurnal	*No flexibility is installed* for conversion or modification of plant to provide a reclaimable effluent.[2]	•		
	2	1980 1985	307 232[3]	Diurnal Diurnal	*Flexibility is installed* for conversion or modification of plant to provide a reclaimable effluent.[2]			•
	3	1980 1985	307[4] 232	Diurnal Diurnal	*Flexibility is installed* for conversion or modification of plant to provide a reclaimable effluent.[2]		•	

FOOTNOTES:

[1] Average annual flow capacity for primary and secondary treatment, unless otherwise noted. This flow does not refer to design capacity.

[2] "Reclaimable effluent" indicates major outfalls would be segregated as needed to assure maximum reduction in high TDS and industrialized waste flows by diversion to non-reclaimable waste streams. "Reclaimable effluent" also refers to those wastewater flows given a high degree of secondary treatment satisfying both carbonaceous and nitrogenous demands, thus requiring the process of nitrification.

[3] The treatment plant capacity in this case is unique with an initial primary and secondary annual average flow capacity of 307 mgd, which is later downrated and converted to 232 mgd capacity with modifications to provide up to 75 mgd of the plant flow as nitrified effluent.

[4] The treatment plant capacity in this case is unique with a primary and secondary annual average design flow capacity of 232 mgd but operated at 307 mgd with an additional but temporary advanced primary treatment to be operated until the La Cienega WRP can be constructed to relieve this load on the Hyperion TP. The advanced primary system requires testing to assure it would provide compliance with the NPDES permit water quality requirements, while the "secondary" requirements of the NPDES permit would have to be changed to allow full compliance during the interim period 1980–1985.

figure 4.2

RECLAIMED WATER SYSTEM COST COMPONENTS

**These Components are Developed for Estimating the Cost
to Provide Reclaimed Water to Potential Uses**

WASTEWATER TREATMENT PLANT MODIFICATIONS

Includes modifying these facilities to provide a reclaimable effluent by improvements such as, sewer segregation, conversion of secondary to fine bubble diffused air, addition of a separate sludge nitrification system, and necessary diversion structures to provide a "pick up" point. See Table 4.12 for identification of modifications required for each reclaimable water system market.

ADVANCED WASTEWATER TREATMENT

Includes providing treatment to the reclaimable effluent of the wastewater treatment plant to assure the quality criteria of each use is met by the reclaimed water supply. The processes that are used include lime-coagulation, filtration, carbon adsorption, denitrification, disinfection, and breakpoint chlorination. See Table 4.13 for identification of the treatment required for each reclaimed water system market.

RECLAIMED WATER DISTRIBUTION SYSTEM

Includes providing a pumping and piping system from the advanced treatment plant to supply each market with reclaimed water. No storage was required to provide the uses described. Where uses requiring the same quality are located together a single common system is developed. The pumping system is developed to provide 85 psi at each potential market use. The distribution piping network will provide a mainline and meter at each potential market's property line. See Figures 4.3 and 4.4 for the nominal location of the distribution system for each potential market with wastewater management plan Alternative B and E, respectively.

TABLE 4.12

WASTEWATER TREATMENT PLANT MODIFICATION REQUIREMENTS

Identification of the Major Modifications Required for Each LA City Wastewater Treatment Plant to Provide a Reclaimable Effluent

	RECLAIMED WATER SYSTEM			WASTEWATER TREATMENT PLANT MODIFICATIONS TO PROVIDE RECLAIMABLE EFFLUENT					
		CAPACITY							
WASTEWATER TREATMENT PLANT	Market ID No.	Date	Total Flow (mgd)	Plant Influent Sewer Changes for Source Control and Modification of Headworks	Demolition of Existing Headworks and Primary Clarifiers	Conversion of Existing Secondary Systems to Provide Nitrification	Installation of New Conduits, Secondary Reactors, and Clarifiers for Nitrification	Modification of Effluent Conduits and Installation of Diversion Structure	Conversion of UNOX System to Fine Bubble (1st Stage)
Sepulveda WRP	1	1980	9						
		1985	54				■	■	
LA–Glendale WRP	2	1980	8						
La Cienega WRP	3	1985	30				■	■	
	4	1985	51				■	■	
	5	1985	71				■	■	
Hyperion TP	6	1985	8				◆ ● ★	◆ ● ★	
	7	1985	38			◆	● ★	◆ ● ★	◆
	8	1985	38						
		1990	73			◆	● ★	◆ ● ★	◆
	9	1985	60			◆	● ★	◆ ● ★	◆
	10	1985	80			◆	● ★	◆ ● ★	◆
	11	1985	80						
		1990	115	◆	◆	◆	◆ ● ★	◆ ● ★	◆
	12	1985	60						
		1990	95	◆	◆	◆	◆ ● ★	◆ ● ★	◆
	13	1985	8						
		1990	43			◆	● ★	◆ ● ★	◆

LEGEND indicates modifications required based on the following treatment plant conditions.

- ■ Upstream Treatment Plant with a reclaimable effluent (B 4, E 1, E 2)
- ● Hyperion TP secondary capacity is 307 mgd with *no flexibility* for conversion to fine bubble aeration. La Cienega Water Reclamation Plant *not* constructed (B 4).
- ◆ Hyperion TP secondary capacity is 307 mgd *with flexibility* for conversion to fine bubble aeration. La Cienega Water Reclamation Plant is constructed in the future with 75 mgd capacity, reducing Hyperion TP loading to 232 mgd (E 2).
- ★ Hyperion TP secondary capacity is 232 mgd *with* fine bubble aeration and with temporary advanced primary. La Cienega Water Reclamation Plant is constructed in the future with 75 mgd capacity and the advanced primary at Hyperion TP is discontinued (E 1).

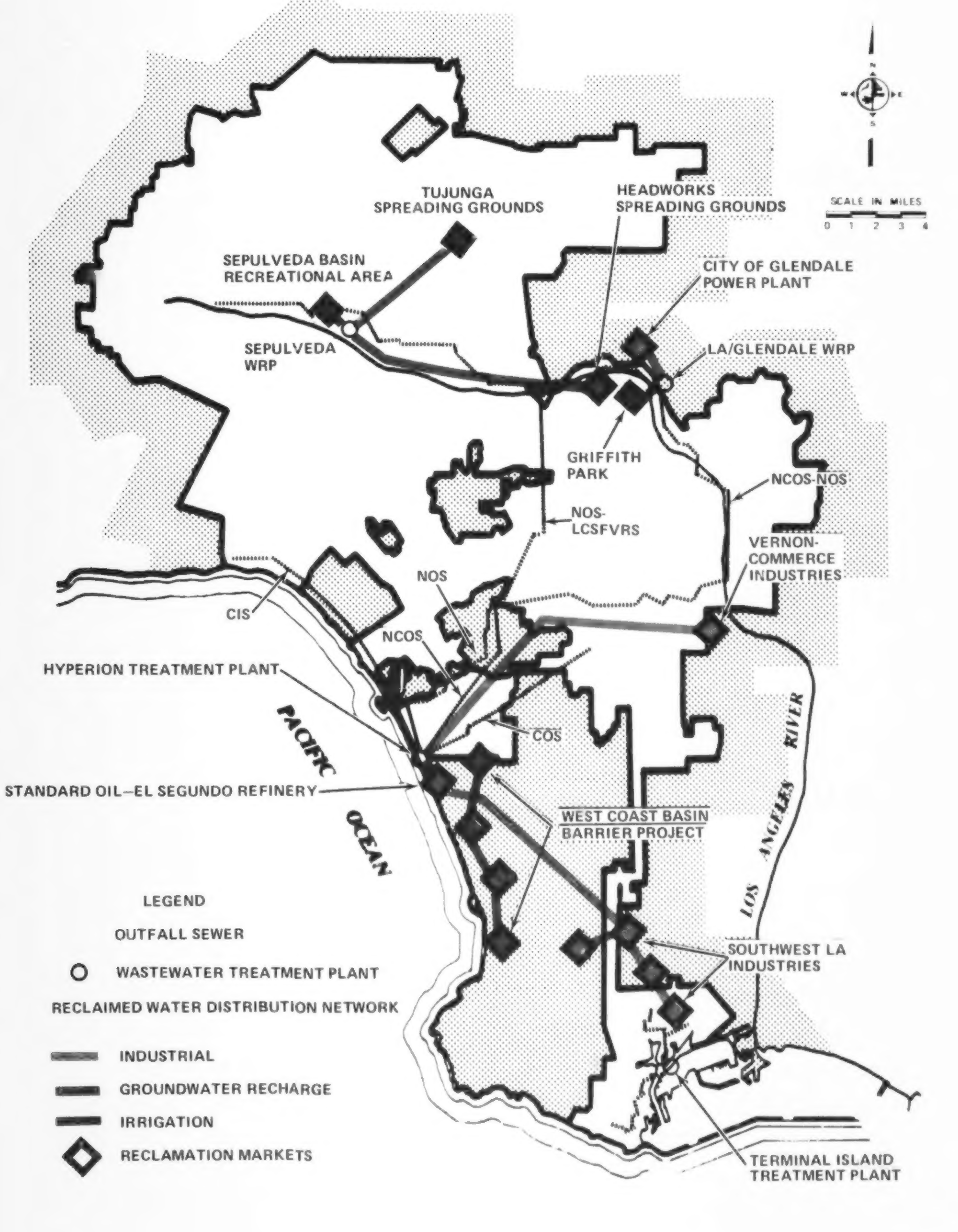
TABLE 4.13

ADVANCED WASTEWATER TREATMENT REQUIREMENTS

Identification of the AWT Required of Each LA City Wastewater Treatment Plant's Effluent to Satisfy Water Quality Criteria for Each Reclaimed Water Use

WASTEWATER TREATMENT PLANT	RECLAIMED WATER SYSTEM				ADVANCED WASTEWATER TREATMENT PROCESS						
	Market ID No.	USE Date	USE Type	Total Flow (mgd)	Lime Coagulation-Sedimentation	Filtration	Carbon Adsorption	Denitrification	Disinfection	Breakpoint Chlorination	No Additional Treatment
Sepulveda WRP	1	1980	IRR	9							●
		1985	GWR	45			●	●			
LA–Glendale WRP	2	1980	IRR	5							●
			PPC	3	●	●			●		
La Cienega WRP	3	1985	IND	30							●
	4	1985	IND	51							●
	5	1985	IND	71							●
Hyperion TP	6	1985	IND	8	●	●			●		
	7	1985	IND	38	●	●			●		
	8	1985	IND	38	●	●			●	●	
		1990	SWB	35	●	●	●				
	9	1985	IND	60	●	●			●		
	10	1985	IND	80	●	●			●		
	11	1985	IND	80	●	●			●		
		1990	SWB	35	●	●	●			●	
	12	1985	IND	60	●	●			●		
		1990	SWB	35	●	●	●			●	
	13	1985	IND	8	●	●			●		
		1990	SWB	35	●	●	●			●	

WRP – Water Reclamation Plant
TP – Treatment Plant
IRR – Irrigation
GWR – Groundwater Recharge
PPC – Power Plant Cooling
IND – Industrial
SWB – Seawater Intrusion Barrier (West Coast Basin Barrier Project)


TUJUNGA SPREADING GROUNDS
HEADWORKS SPREADING GROUNDS
SCALE IN MILES
0 1 2 3 4
SEPULVEDA BASIN RECREATIONAL AREA
CITY OF GLENDALE POWER PLANT
SEPULVEDA WRP
LA/GLENDALE WRP
GRIFFITH PARK
NCOS-NOS
NOS-LCSFVRS
VERNON-COMMERCE INDUSTRIES
NOS
CIS
NCOS
HYPERION TREATMENT PLANT
PACIFIC OCEAN
COS
STANDARD OIL—EL SEGUNDO REFINERY
WEST COAST BASIN BARRIER PROJECT
LOS ANGELES RIVER
LEGEND
OUTFALL SEWER
WASTEWATER TREATMENT PLANT
RECLAIMED WATER DISTRIBUTION NETWORK
INDUSTRIAL
GROUNDWATER RECHARGE
IRRIGATION
RECLAMATION MARKETS
SOUTHWEST LA INDUSTRIES
TERMINAL ISLAND TREATMENT PLANT

198P-431

Figure 4.3. Distribution systems for major reclaimed water uses.

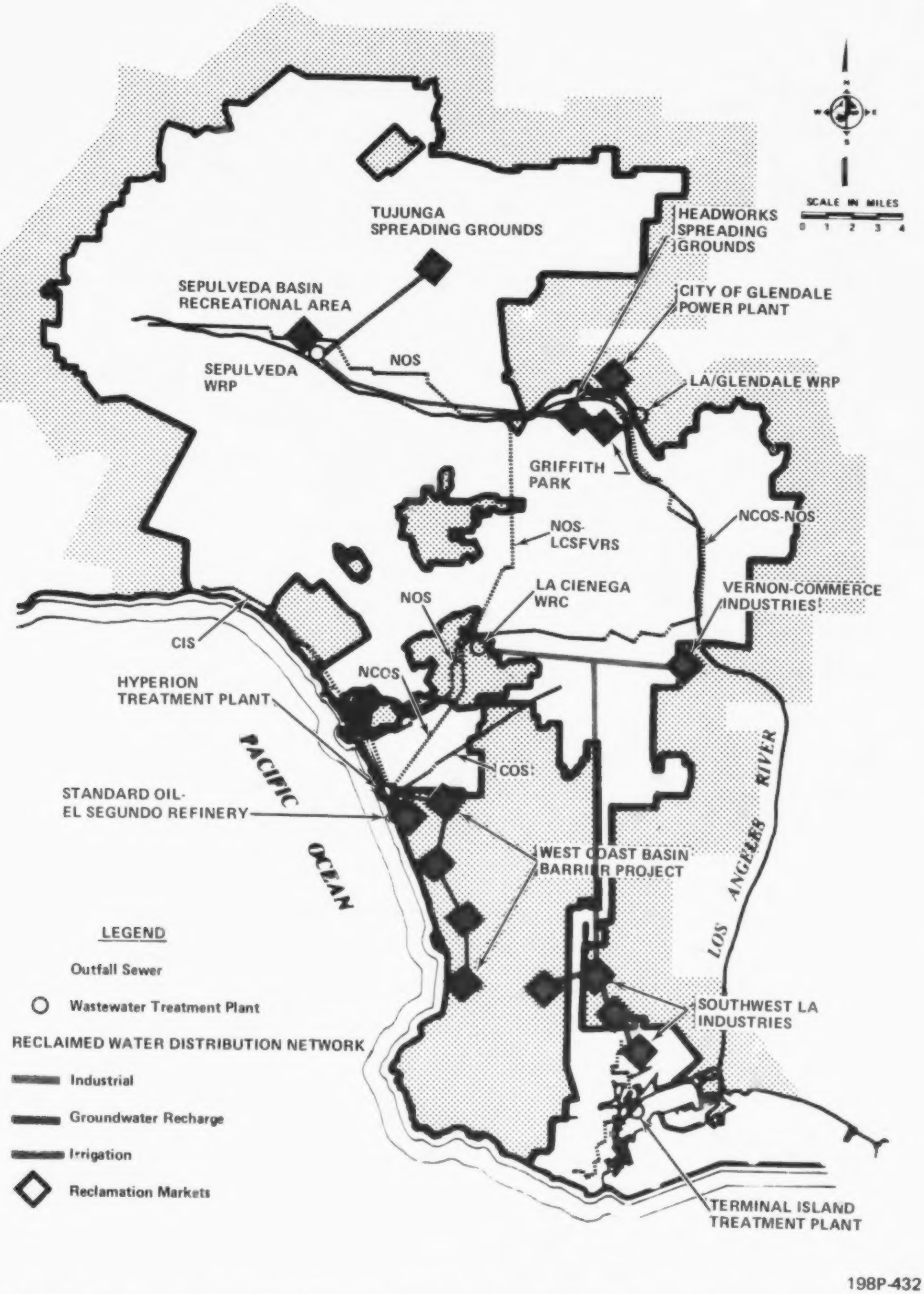

TUJUNGA
SPREADING GROUNDS
HEADWORKS
SPREADING
GROUNDS
SCALE IN MILES
0 1 2 3 4
SEPULVEDA BASIN
RECREATIONAL AREA
CITY OF GLENDALE
POWER PLANT
NOS
SEPULVEDA
WRP
LA/GLENDALE WRP
GRIFFITH
PARK
NCOS-NOS
NOS-
LCSFVRS
LA CIENEGA
WRC
NOS
VERNON-COMMERCE
INDUSTRIES
CIS
HYPERION
TREATMENT PLANT
NCOS
PACIFIC
COS
STANDARD OIL-
EL SEGUNDO REFINERY
OCEAN
WEST COAST BASIN
BARRIER PROJECT
LOS ANGELES RIVER
LEGEND
Outfall Sewer
Wastewater Treatment Plant
RECLAIMED WATER DISTRIBUTION NETWORK
Industrial
Groundwater Recharge
Irrigation
Reclamation Markets
SOUTHWEST LA
INDUSTRIES
TERMINAL ISLAND
TREATMENT PLANT
198P-432

Figure 4.4. Distribution systems for major reclaimed water uses.

TABLE 4.14

RECLAIMED WATER SYSTEM ALTERNATIVES

Matrix of Reclaimed Water Markets which are Combined to Form Unique Systems for Cost Comparison of Wastewater Management Plan Alternatives B and E

Reclaimed Water System Alternative No. (Figure 4.1)	RECLAIMED WATER MARKET IDENTIFICATION NO. (Table 4.10)												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1	B, E	B, E	E			E	B						
2	B, E	B, E	E					B					E
3	B, E	B, E		E		E			B				
4	B, E	B, E		E								B	E
5	B, E	B, E			E	E				B			
6	B, E	B, E			E						B		E

LEGEND:

B represents Wastewater Management Plan Alternative B.

E represents Wastewater Management Plan Alternative E.

TABLE 4.15

ENERGY IMPACT OF ALTERNATIVE WASTEWATER MANAGEMENT PLANS ON WATER RECLAMATION

		Increased Energy Demand for Providing Reclaimed Water to Use with Wastewater Management Plan Alternative B over E for the Period 1980–2000	
Reclaimed Water Use	**Change in System**	**Billions of Kilowatt–Hours**	**Millions of Barrels of Oil***
Industrial – *Southwest Los Angeles Industries*	*Increased Demand from 0 to 30 mgd*	0.7	1.2
Industrial – *Southwest Los Angeles Industries*	*Increased Demand from 30 to 52 mgd*	0.6	1.0
Industrial – *Vernon Industries*	*Increased Demand from 0 to 20 mgd*	0.5	0.8
Seawater Intrusion Barrier – *West Coast Basin Barrier Project*	*Increased Demand from 0 to 35 mgd*	0	0

*Based on DWP facilities average generation value of 10,000 btu/kwy with oil of a 6 million btu/barrel heating value.

TABLE 4.16

ENERGY REQUIREMENTS FOR ALTERNATIVE RECLAIMED WATER SYSTEMS

Energy Requirements for Treatment and Distribution to Provide Reclaimed Water to Uses– Direct, Indirect and Total for the Period 1980 through 2000 and Unit Average During the Period

		ENERGY REQUIREMENTS FOR THE PERIOD 1980–2000 (BKwh)*							
		Direct		Indirect		Total		Unit (Kwh/AF)	
		WASTEWATER MANAGEMENT PLAN ALTERNATIVE							
Reclaimed Water System Alt. No.	**Total Quantity Reclaimed in the Period 1980–2000 (millions acre-ft.)**	**B**	**E**	**B**	**E**	**B**	**E**	**B**	**E**
1	1.75	1.51	1.40	1.23	0.65	2.74	2.05	1560	1170
2	2.14	1.90	1.79	2.08	1.50	3.98	3.29	1860	1540
3	2.11	2.30	2.05	1.65	0.65	3.95	2.70	1870	1280
4	2.50	2.69	2.43	2.50	1.50	5.19	3.93	2080	1570
5	2.44	2.66	2.29	2.03	0.65	4.69	2.94	2300	1440
6	2.83	3.05	2.68	2.88	1.50	5.93	4.18	2100	1480

*Energy requirements for Alternatives B and E are not directly comparable because the effluent qualities of these two alternatives are not equal.

TABLE 4.17

LAND REQUIREMENTS FOR WATER RECLAMATION

Total Land Area Needed in the Vicinity of Wastewater Treatment Plants for Additional Treatment to Provide Reclaimed Water to Various Uses

RECLAIMED WATER USE	WASTEWATER TREATMENT PLANT	TOTAL LAND REQUIREMENTS FOR PROVIDING RECLAIMED WATER TREATMENT (in acres)		
		B–4	E–1	E–2
1. Irrigation SBRA (9 mgd) Groundwater Recharge HSG/TSG (45 mgd)	Sepulveda WRP	15	15	15
2. Irrigation Griffith Park (5 mgd) Power Plant Cooling City of Glendale (3 mgd)	LA–Glendale WRP	1	1	1
3. Industrial	La Cienega WRP	—	4	4
Level 1 (38 mgd)	Hyperion TP	17	5	5
4. Industrial	La Cienega WRP	—	6	6
Level 2 (60 mgd)	Hyperion TP	29	5	5
5. Industrial	La Cienega WRP	—	8	8
Level 3 (80 mgd)	Hyperion TP	35	5	5
6. Seawater Intrusion Barrier WCBBP (35 mgd)	Hyperion TP	18	18	9

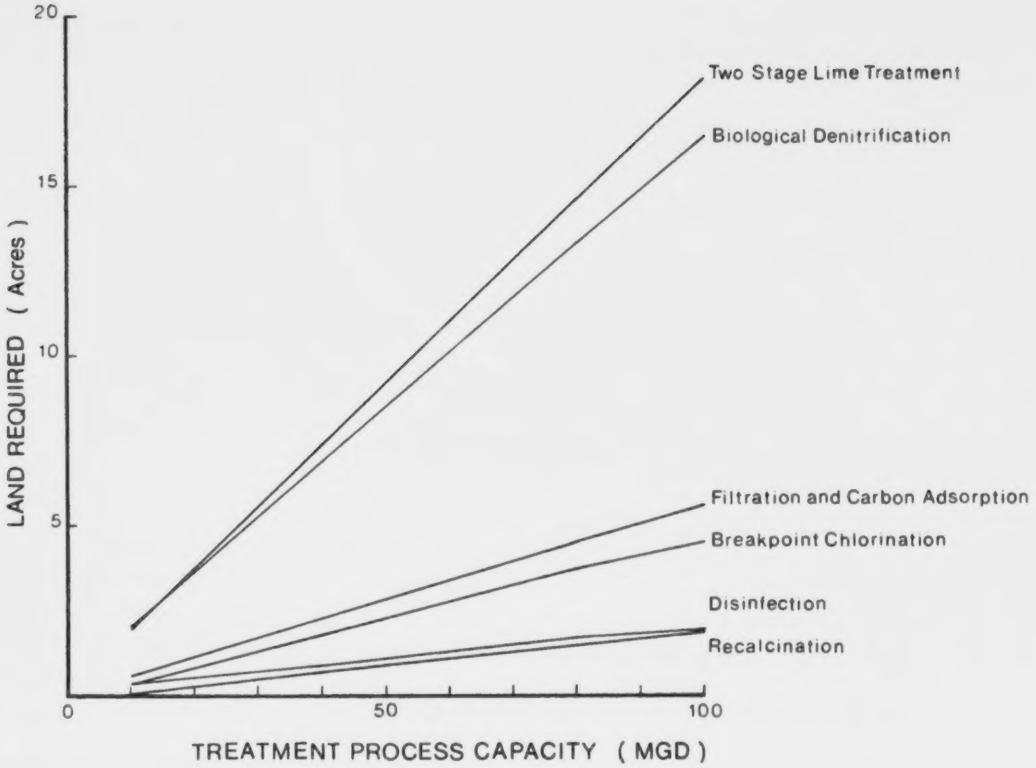
USES LEGEND:

SBRA – Sepulveda Basin Recreational Area
HSG – Headworks Spreading Grounds
TSG – Tujunga Spreading Grounds
WCBBP – West Coast Basin Barrier Project

Industrial Level 1 – SWLA (30 mgd), Std. Oil (8 mgd)
Level 2 – SWLA (52 mgd), Std. Oil (8 mgd)
Level 3 – SWLA (52 mgd), Std. Oil (8 mgd), Vernon (20 mgd)

figure 4.5

LAND REQUIREMENTS FOR ADVANCED TREATMENT PROCESSES



Ref: *A Guide to the Selection of Cost-Effective Wastewater Treatment Systems*

EPA - 430/9-75-002, July 1975

TABLE 4.18

LAND AVAILABILITY FOR WATER RECLAMATION

Description of the Land Available in the Vicinity[1] of the Wastewater Treatment Plants for Additional Treatment for Alternative Wastewater Management Plans B and E

WASTEWATER TREATMENT	TOTAL LAND AVAILABLE FOR PROVIDING RECLAIMED WATER TREATMENT (in acres)		
	B–4	E–1	E–2
Sepulveda WRP	40	40	40
LA–Glendale WRP	1[2]	1[2]	1[2]
La Cienega WRP	–	8[4]	8[4]
Hyperion TP	25/24[3]	25	24

[1] Vicinity indicates on-site wastewater treatment plant property unless otherwise noted.

[2] City of Glendale's property near their power plant.

[3] Indicates land available with/without (respectively) redesign and relocation of proposed facilities needed to upgrade Hyperion TP to meet requirement of PL 92–500.

[4] Assumes that 37 acres acquired for plant site.

TABLE 4.19

LAND DEFICIENCY FOR WATER RECLAMATION

Total Additional Land Area Needed in the Vicinity of Wastewater Treatment Plants for Additional Treatment to Provide Reclaimed Water to Various Uses

RECLAIMED WATER USE	WASTEWATER TREATMENT PLANT	TOTAL LAND DEFICIENCY (acres)		
		B–4	E–1	E–2
1. Irrigation SBRA (9 mgd) Groundwater Recharge HSG/TSG (45 mgd)	Sepulveda WRP	0	0	0
2. Irrigation Griffith Park (5 mgd) Power Plant Cooling City of Glendale (3 mgd)	LA–Glendale WRP	0	0	0
3. Industrial	La Cienega WRP	––	0	0
Level 1 (38 mgd)	Hyperion TP	0	0	0
4. Industrial	La Cienega WRP	––	0	0
Level 2 (60 mgd)	Hyperion TP	4–5	0	0
5. Industrial	La Cienega WRP	––	0	0
Level 3 (80 mgd)	Hyperion TP	10–11	0	0
6. Seawater Intrusion Barrier WCBBP (35 mgd)	Hyperion TP	18	0	0

NOTES:

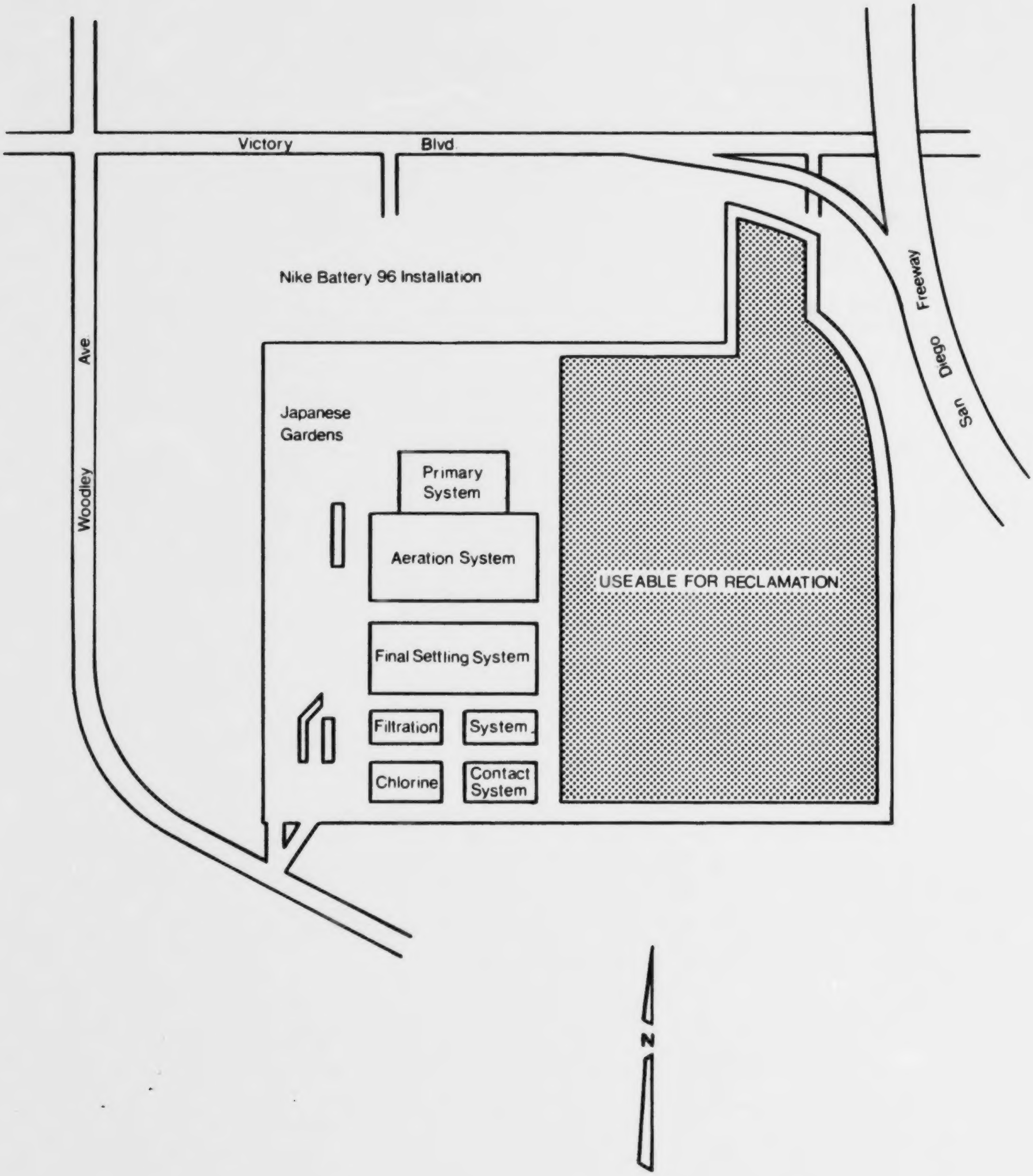
a. Deficiency indicated for uses at the Hyperion TP are additive, i.e., if Industrial and Seawater Intrusion Barrier uses are provided for then the total deficiency is the sum of the number presented. Deficiency for Alternative B–4 at Hyperion TP is presented based on with/without (respectively) redesign and relocation at proposed facilities needed to upgrade Hyperion TP.

b. The 37-acre site for the proposed La Cienega WRP is assumed to have been acquired.

c. See Table 4.17 for USE LEGENDS and INDUSTRIAL LEVELS.

figure 4.6

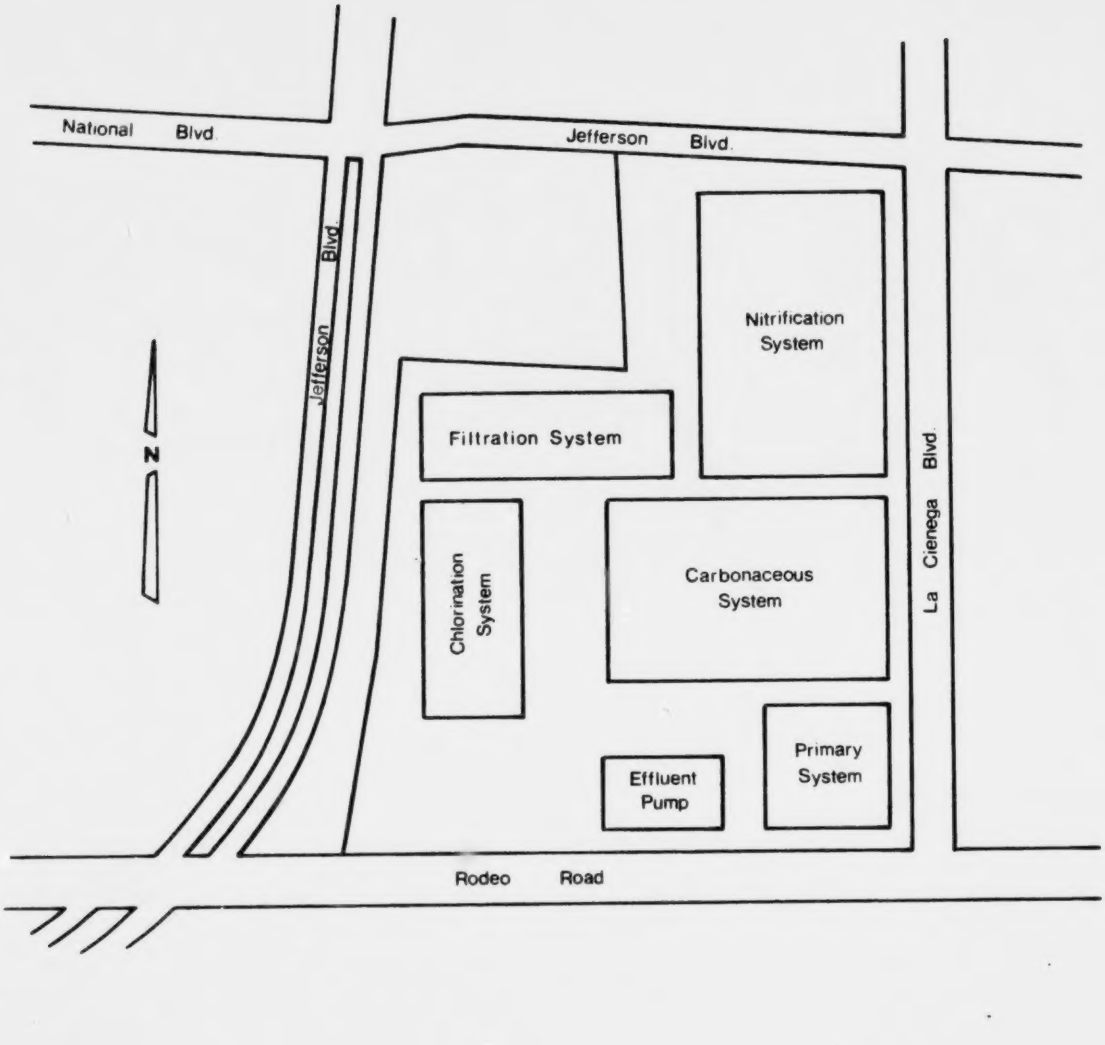
SEPULVEDA WATER RECLAMATION PLANT FACILITIES LAYOUT FOR ALTERNATIVES B AND E


Victory
Blvd
Nike Battery 96 Installation
Woodley
Ave
Japanese
Gardens
Primary System
Aeration System
Final Settling System
Filtration
System
Chlorine
Contact System
USEABLE FOR RECLAMATION
San
Diego
Freeway
N

87

figure 4.7

LA CIENEGA WATER RECLAMATION PLANT PROPOSED FACILITIES LAYOUT FOR ALTERNATIVE E


National Blvd.
Jefferson Blvd.
Jefferson Blvd.
N
Nitrification System
Filtration System
Chlorination System
Carbonaceous System
La Cienega Blvd.
Primary System
Effluent Pump
Rodeo Road

88

figure 4.8

HYPERION TREATMENT PLANT
CURRENT FACILITIES LAYOUT FOR ALTERNATIVE B-4

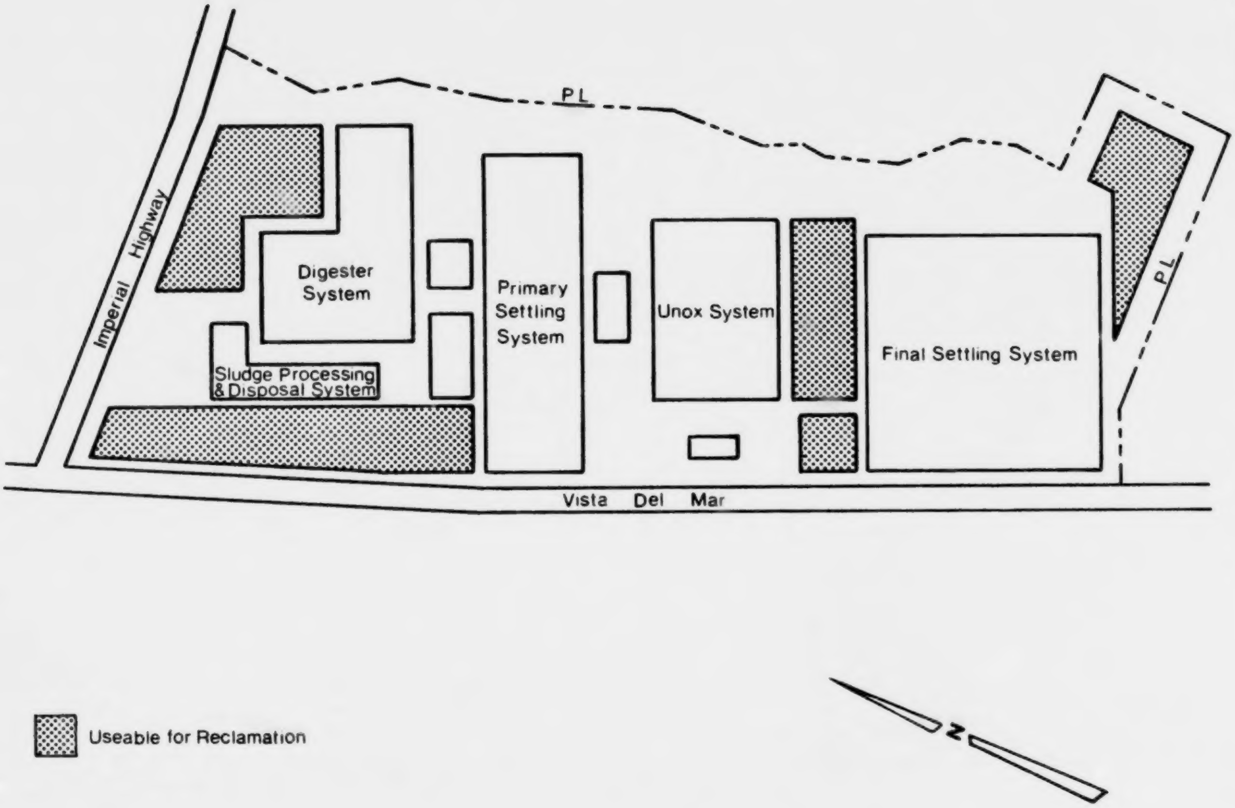

P L
Imperial Highway
Digester System
Sludge Processing & Disposal System
Primary Settling System
Unox System
Final Settling System
P L
Vista Del Mar
N
Useable for Reclamation

figure 4.9

HYPERION TREATMENT PLANT REVISED FACILITIES LAYOUT FOR ALTERNATIVE B-4

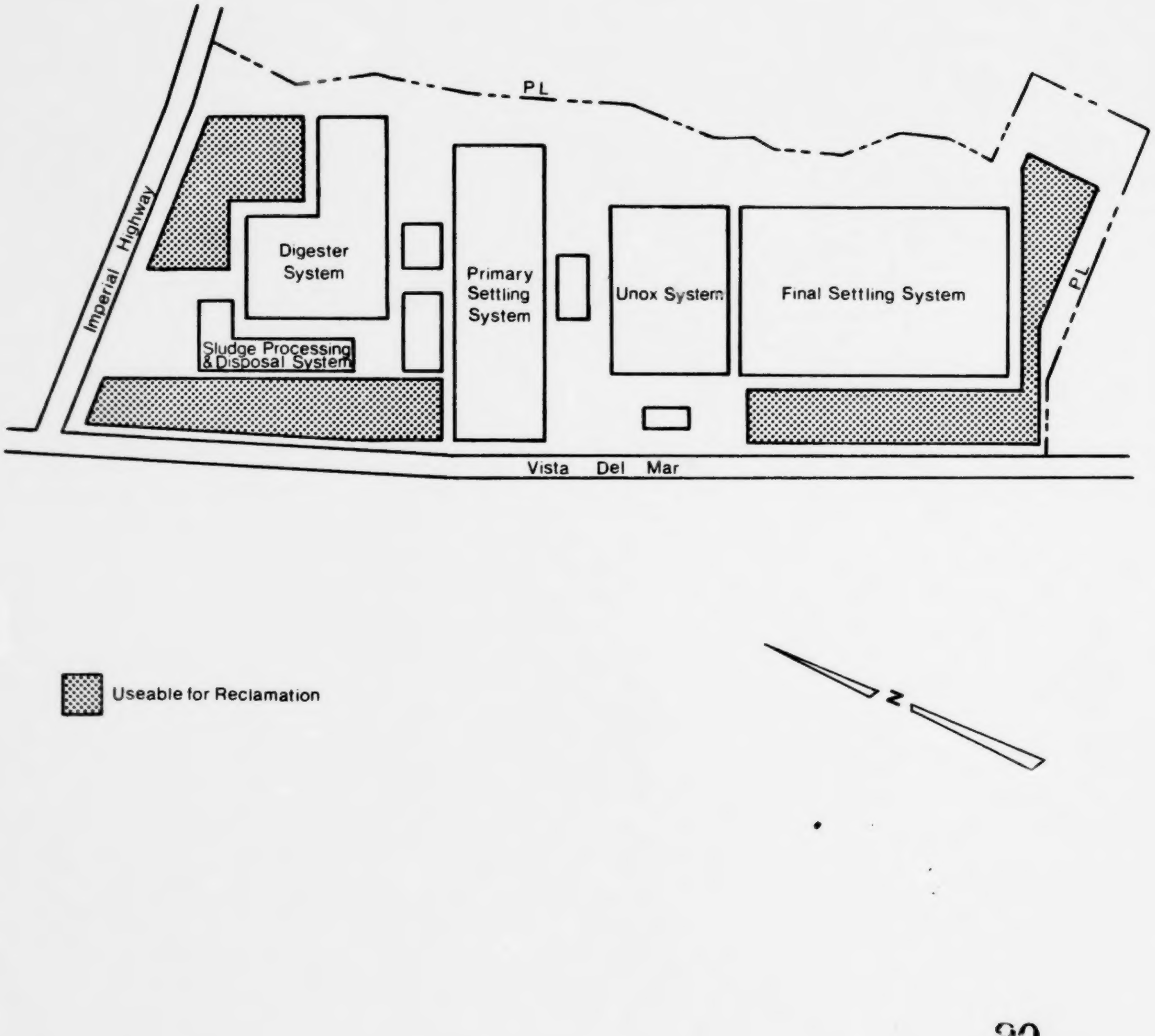

P L
Imperial Highway
Digester System
Sludge Processing & Disposal System
Primary Settling System
Unox System
Final Settling System
P L
Vista Del Mar
▨ Useable for Reclamation
N

figure 4.10

HYPERION TREATMENT PLANT
PROPOSED FACILITIES LAYOUT FOR ALTERNATIVE E-1

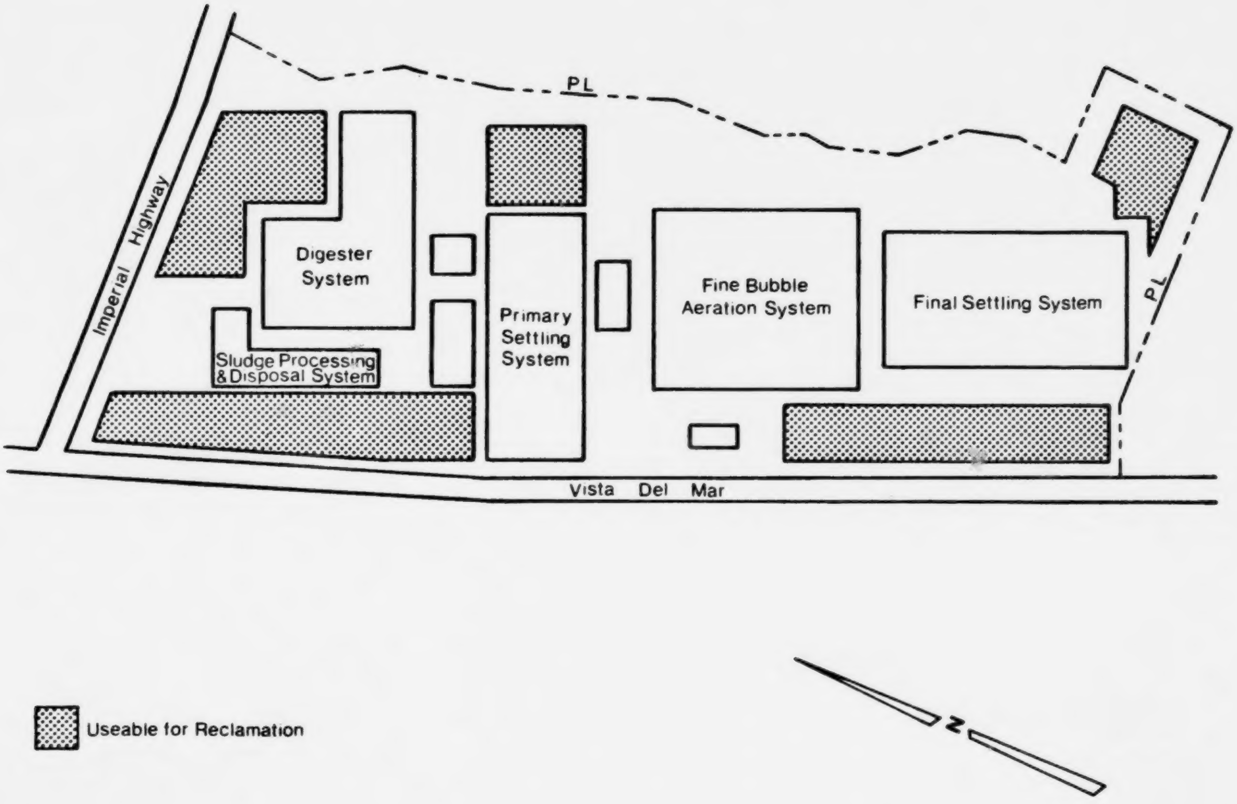
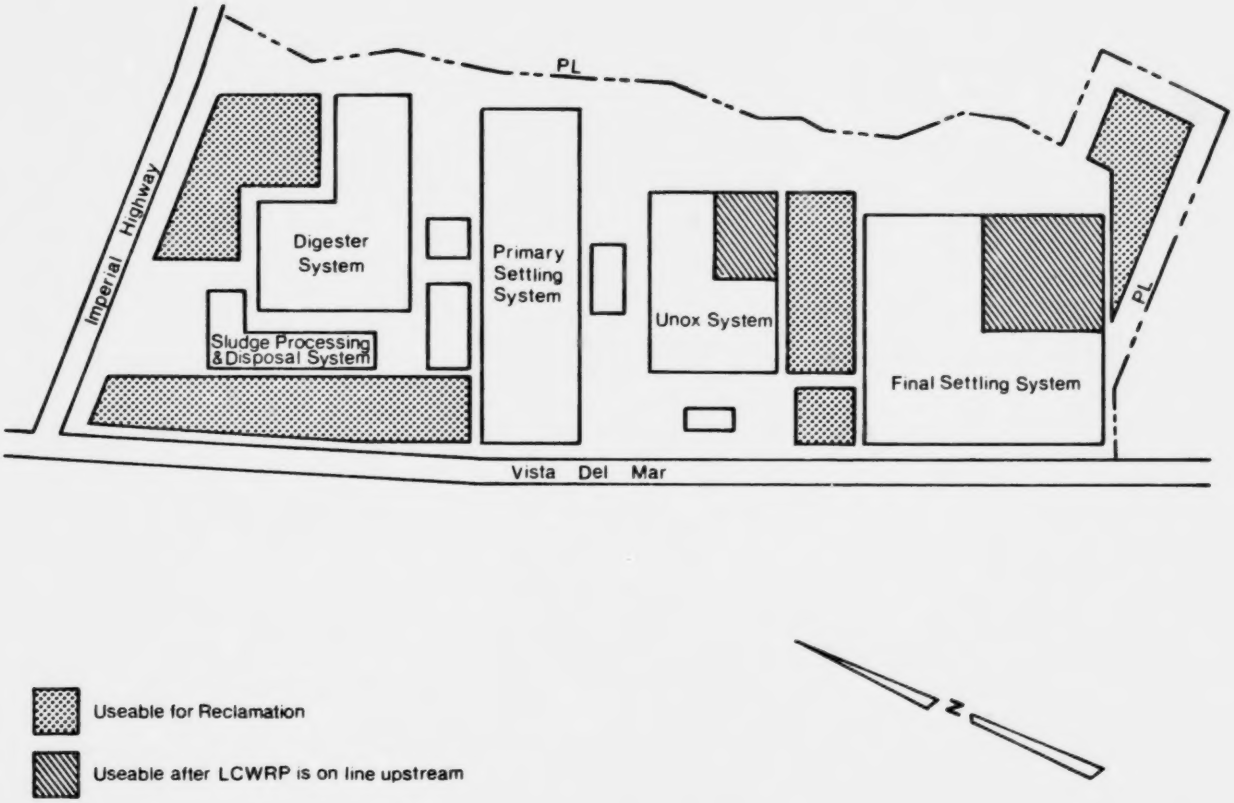

PL
Imperial Highway
Digester System
Sludge Processing & Disposal System
Primary Settling System
Fine Bubble Aeration System
Final Settling System
PL
Vista Del Mar
N
▨ Useable for Reclamation

figure 4.11

HYPERION TREATMENT PLANT
PROPOSED FACILITIES LAYOUT FOR ALTERNATIVE E-2


PL
Imperial Highway
Digester System
Sludge Processing & Disposal System
Primary Settling System
Unox System
Final Settling System
PL
Vista Del Mar
N
Useable for Reclamation
Useable after LCWRP is on line upstream

CHAPTER 5

FINANCIAL ANALYSIS OF RECLAIMED WATER SYSTEMS

This chapter presents the basis, procedure, background, and results of a financial analysis conducted for the uses of reclaimed water identified in Chapter 4.

The purpose of this analysis is to determine if water reclamation is self-supporting and the amount of revenue and outside funding needed to ensure the financial feasibility of water reclamation. The analysis presented is one approach for assessing financial feasibility. Although the proposed method may not be the best method, it does indicate the degree of funding required and allows a comparison of the financial aspects of the two wastewater management plan alternatives.

For purposes of this report, water reclamation is defined as being financially feasible if there is no increase in the cost of water supply to any individual water user, water purveyor, or water supplier as a result of developing reclaimed water. In addition, those agencies who ultimately benefit from the development of water reclamation should provide financial support for reclamation if required. If outside funding is required to prevent increases in local water supply costs, that funding is proposed to come from the State Water Project through its contractors by making water reclamation an element of that project. The State Water Project was chosen as a potential source of funding because any reclaimed water developed in the Los Angeles area can be translated to a reduction in the local demand for State Project water, thus being equivalent to developing a new water source. The State Project water released in the Los Angeles area would be available to other Project contractors in the State. No determination was made as to the cost-effectiveness of reclaimed water as an alternate source of supply for the State Water Project.

5.1 SUMMARY

A financial analysis was conducted to determine the level of funding through revenues and subsidies required to implement water reclamation in the Los Angeles area. This analysis involved the following basic steps:

1. Identification of potential reclaimed water users, existing water purveyors and water sources, and total quantity of domestic water displaced during the planning period.
2. Determination of existing domestic water payments, user penalty costs, fixed and variable costs of water purveyor and water wholesaler, and revenue lost by displacement of existing domestic water service.
3. Determination of cash flow between reclaimed water user, existing water purveyor, reclaimed water supplier, and existing water wholesaler.
4. Determination of revenue deficit which is proposed to be funded by the State Water Project.

The basic considerations in this analysis were that the potential reclaimed water users should not pay more for reclaimed water (including penalty costs) than the current domestic supply and no domestic or reclaimed water supply agency should incur a financial loss due to displacement of the existing domestic water supply by reclaimed water.

The cash flow of revenues, costs, and payments which resulted from this financial analysis is presented in flow-chart form in Figures 5.7 through 5.12 for each of the six reclaimed water system alternatives developed in Chapter 4 and shown on Figure 4.1. These flow charts present the estimated monetary exchanges which would be necessary to maintain financial equity for both Wastewater Management Plan Alternatives B-4 and E-1, to show the difference between the plans *and* the magnitude of monetary exchanges involved in the development of financially feasible reclaimed water systems. In all cases it was found that water reclamation in the Los Angeles area may not be financially feasible unless some outside source of funding is available such as through including water reclamation as an element of the State Water Project. The magnitude of this outside funding ranged from $176 million to $369 million (present worth, 1975 dollars) over the planning period 1980-2000, depending on the level of reclamation being pursued and the selected Wastewater Management Plan Alternative.

If Wastewater Management Plan Alternative B is implemented instead of E, to make water reclamation financially feasible, a greater subsidy would be required from the State Water Project. The magnitude of the difference in subsidy needed varies with the level of water reclamation developed, as shown in Table 5.9, and ranges from $20 million for 1.76 million acre-feet to $73 million for 2.86 million acre-feet (dollars are total present worth in 1975 and flows are totals for the period 1980 through 2000). These results show that if the City and State select Wastewater Management Plan Alternative B, and if water reclamation develops and is to be financially feasible, the State Water Project or other source of funding could face an *additional* financial burden in the range of $20 to $73 million in comparison to that required for Alternative E for the period 1980 through 2000.

5.2 BASIS OF FINANCIAL ANALYSIS

In developing this analysis, it was necessary to decide how the costs for water reclamation would be shared by the various involved agencies while maintaining financial equity to all. The agencies considered were: the potential reclaimed water users; the local water purveyor (who supplies the users source of domestic water); the producer of reclaimed water; the Metropolitan Water District (MWD) (who wholesales domestic water to local purveyors); and the Department of Water Resources, as managers of the State Water Project (who supplies water to MWD).

In order to select which agencies would be involved in the financial analysis, the following points were considered:

1. The implementation of a large volume reuse of reclaimed water by an agency receiving water from the State Water Project constitutes development of a new water source for the State Water Project as much as would construction of new water gathering facilities (reservoirs, aqueducts, etc.) in the area of origin.

2. If additional water were developed for the State Water Project at its area of origin, it is assumed the water would be good quality and a user of said water project (agricultural or municipal or industrial) would not expect to pay a penalty due to inferior quality. Similarly, a user of reclaimed water should not be required to assume any increased costs for having converted to that source.

3. The existing water suppliers in the area where reclaimed water use is to occur should not be penalized by such development. They would not be hurt by an improvement in the State Water Project. For example, if the industries considered in this report are converted to reclaimed water use, a new water supply system will be installed. This new system may make a portion of the existing water distribution system obsolete. The local water utility thus should be made whole for any financial burdens imposed by the inclusion of a reclaimed water supply in his service area.

4. If the sum of the costs associated with providing reclaimed water exceeds the price a potential user would expect to pay, this difference between price and cost should be paid by all the users of the State Water Project. Water reclamation by any user of the State Water Project reduces demands on that project, making an equal volume of water available for other users. Obviously, this assumes the user is operating within his contracted quota of project water since this is all the State is obligated to provide.

The analysis of costs based on these considerations led to a recommendation for involvement of an agency which, heretofore, had not held any responsibility for funding water reclamation in Southern California. This agency, which might be one or a combination of existing State agencies, or contractors to the State Water Project, is tentatively identified in this report as the "Department of Water Resources (DWR) or other agency interested in the development of water for the State Water Project." This agency would have direct or indirect responsibility to supply water for the State Water Project, can collect money from State Water Project contractors, and wants to encourage water reclamation as a supplement to that project. No attempt has been made in this study to determine the amount of additional water needed by the State Water Project, or if development of water reclamation in the Los Angeles area as an indirect source to the State Water Project, would be as economical, reliable, or desirable as other new sources now under consideration. Such analysis would be required before a substantial reclamation program could be implemented.

In an effort to maintain financial equity to all involved agencies, it became necessary to define the costs that would be impacted by conversion to reclaimed water use. To do this, the following points were considered. Each of these agencies is identified in the flow charts in Figures 5.7 through 5.12.

1. Reclaimed Water User – The user of reclaimed water must be provided a water service which satisfies demands equal to that of the domestic water service and at a cost which does not change any of the users' financial requirements for water use. If water quality penalty costs are incurred in using reclaimed water beyond those incurred in the use of existing supplies, then that difference would be the amount of reduced revenues to be collected from the sale of reclaimed water.

2. Local Water Purveyor – The local water purveyors who currently serve domestic water to the potential reclaimed water users, will serve the reclaimed water and will recover all fixed costs associated with termination of the use of the domestic supply through the sale of reclaimed water.

3. Reclaimed Water Producer – The agency developing and producing reclaimed water will recover all costs through water sales to the local water purveyors and through collection from the State Department of Water Resources, or other agencies for diverting State Water Project water for use by others.

4. Metropolitan Water District – This agency will recover all fixed costs associated with termination of the use of the domestic supply through payments or credits from the State Water Project.

5. Department of Water Resources (or other interested agency) – This agency will make payments to MWD and the agency developing reclaimed water equal to the collection of revenues from the State Water Project contractors for an amount of water equivalent to the reclaimed water supply.

5.3 ANALYSIS PROCEDURE

The procedure used to estimate the financial exchanges necessary to meet the basis given above for the sale of reclaimed water in the Los Angeles area is presented below. A description of the assumptions used in this analysis is presented in Table 5.7.

Financial Analysis Procedure

Procedure	**Reference**
1. The potential reclaimed water user, existing water purveyor, sources of water, and the interrelationship of each were identified for each reclaimed water market presented in Table 4.10.	Figures 5.1, 5.2 5.3, 5.4 5.5, 5.6
2. The total quantity of domestic water service that might be interrupted during the period 1980 through 2000 by the use of reclaimed water was identified for each of the six reclaimed water system alternatives presented in Figure 4.1.	Table 5.1 Domestic Water Services Interrupted by Proposed Reclaimed Water Uses
3. The estimated payments each water user would have made for domestic water service from local purveyors from 1980 through 2000 was determined on: 1) the price of water from the Metropolitan Water District of Southern California, 2) pumping assessments and extraction costs for the use of groundwater in the Central and West Basins, and 3) the fixed and variable costs of water sources served by each local water purveyor.	Table 5.2 Total Estimated Payments by Potential Reclaimed Water Users for Purchase of Domestic Water from Local Water Purveyors

Procedure	Reference
4. The estimated payments the water user would willingly make to the local water purveyor for the use of reclaimed water instead of domestic supplies is equal to the payment for domestic water supplies minus any penalty cost related to the use of reclaimed water, plus the revenues for the assumed sale of groundwater rights. Penalty costs include: 1) TDS and hardness penalties (Table 5.8), 2) cost for separate potable distribution systems where necessary, and 3) increased sewer service charges. (Note: Adjudicated groundwater rights currently used by local industries would no longer be required when a reclaimed water service is provided. Those rights are assumed to be sold annually to local water purveyors in the Basin for domestic use.)	Table 5.3 Total Estimated Payments by Potential Reclaimed Water Users for Purchase of Reclaimed Water
5. The estimated payment by the water purveyors serving reclaimed water to the producer of reclaimed water is the sum of the projected revenues from the sale of reclaimed water (Table 5.3) and the sale of groundwater rights no longer used by the purveyor, less the purveyor's fixed cost (not including variable costs) for providing such service.	Table 5.4 Total Estimated Payments by Water Purveyors to Reclaimed Water Producer
6. The estimated revenue deficit from the sale of reclaimed water is the sum of the cost to produce reclaimed water less the payments for reclaimed water service received from the local water purveyor (Table 5.4). The cost to provide reclaimed water was based on Chapter 4 information and Tables 4.7 and 4.8.	Table 5.5 Total Estimated Reclaimed Water Producer Revenue Requirements
7. The estimated net outside revenue needed to support the development of reclaimed water is the sum of the revenue deficit from the sale of reclaimed water (Table 5.5) and the MWD fixed costs associated with the reduction in domestic water service supplied by them. The MWD fixed costs were estimated, including fixed capital and operations and maintenance cost liabilities of MWD for both their own treatment and distribution system and their portion of the State Water Project.	Table 5.6 Total Estimated Revenue Requirements for Production and Use of Reclaimed Water

5.4 BACKGROUND

Reclaimed Water Uses

Griffith Park, Sepulveda Basin Recreation Area, and Central Los Angeles City Customers

The irrigation uses and domestic water customers identified above are served by the City of Los Angeles Department of Water and Power. There are three sources of water normally used to supply these customers as indicated in Figure 5.1. However, it is assumed that any reduction in domestic water service due to the use of reclaimed water in the DWP service area, would result in an equivalent reduction in the MWD source only.

Glendale Steam Plant

The cooling tower for the City of Glendale's Steam Plant is served from the City of Glendale's water system. Figure 5.2 identifies the distribution of the sources of water served by the City of Glendale in 1975 and applies generally throughout their system, not necessarily at the steam plant. Interruption in water service to this use for conversion to reclaimed water use is assumed to result in an equivalent reduction in the MWD source.

Standard Oil Refinery

The water used by the Standard Oil Refinery in El Segundo is served by the City of El Segundo. Figure 5.3 identifies the distribution of the water sources for this use.

Southwest Los Angeles Area Industries

The industries in the Southwest Los Angeles area receive water from several agencies and sources. Three water purveyors (City of Los Angeles, City of Torrance, and the Dominguez Water Corporation) were identified from the 1975 West Basin Watermaster Report, DWR Bulletin 179-75. These agencies serve 43 percent of the water used by the industries in this area. The remaining 57 percent of water used by these industries is obtained from local groundwater, to which they have adjudicated rights.

The water sources used in 1975 by the industries and the water purveyors involved are shown in Figure 5.4. Interruption of these sources to serve the industries' reclaimed water would result in a redistribution of groundwater and surface water use in the area.

Vernon Industries

The water used by industries in the City of Vernon is served by the City of Vernon. The sources of water served are identified in Figure 5.5.

West Coast Basin Barrier Project

The Barrier uses water delivered through the Metropolitan Water District as identified in Figure 5.6. The responsibility for injection of the water and the maintenance of the barrier facilities is assigned to the Los Angeles County Flood Control District. The payment for the water is made by the Central and West Basin Water Replenishment District, which receives revenues collected from the pumpers in the Central and West Coast Basins who pay pumping assessments equal to the cost of all replenishment water in both basins.

Penalty Cost of Using Reclaimed Water

Penalty cost is defined as the cost incurred by a consumer as a result of using a lower quality water than the current source water (reference water). Penalty costs are differences in customer's treatment cost relative to the reference water and added costs resulting from reclaimed water use. These added costs include the cost of additional quantities of water which may be necessary for some uses because of the higher salinity of reclaimed water, additional sewer service charges because of increased wastewater loads or flows, and the cost of separate transmission facilities for reclaimed water. All of these costs must be assessed and quantified to determine the true cost of reclaimed water before it may be compared with alternate sources of water.

Quality-related differences between reclaimed and alternate sources of water may be compared directly if the dollar value of quality can be expressed as a function of specific water quality parameters. This is done through the use of quality adjustment cost curves derived and developed by Charles H. Lawrence *(Existing Indirect Cost of Urban Water Use*, Journal Environmental Engineering Division, ASCE, Vol. 100, August 1975), and refined for use by Basin 4B contractors for the California Water Quality Control Plan and later applied in the Joint Outfall System Facilities Plan for the Sanitation Districts of Los Angeles County EIS/EIR.

Penalty costs incurred usually can be related to either hardness or TDS or a combination of both. For industrial water reuse (water delivered exclusively to industrial plants and used primarily for sanitation, manufacturing, and process operations within the plants), indirect quality-related costs are a function of TDS ONLY (TDS is responsible for corrosion of ferrous metals and dezincification of vulnerable copper alloys, piping damage, increased cooling water blowdown, etc.). Quality-related costs attributed to water reuse for irrigation are a function of both TDS (impact on waterworks, valves, hydrants and meters), and total hardness (TH). Indirect costs for water reuse in groundwater replenishment are also assessed from the impacts of high TDS and TH. Impacts of TH, and cost associated thereof, are evaluated at the domestic and commercial point of use for the latter two uses, since it is assumed that all or part of the reclaimed water used for groundwater replenishment and irrigation will reach groundwater aquifers and ultimately reach the domestic consumer. Total hardness is responsible for increased wear and tear on laundered fabrics and increased consumption of soaps, detergents, cleaners, or chelating agents.

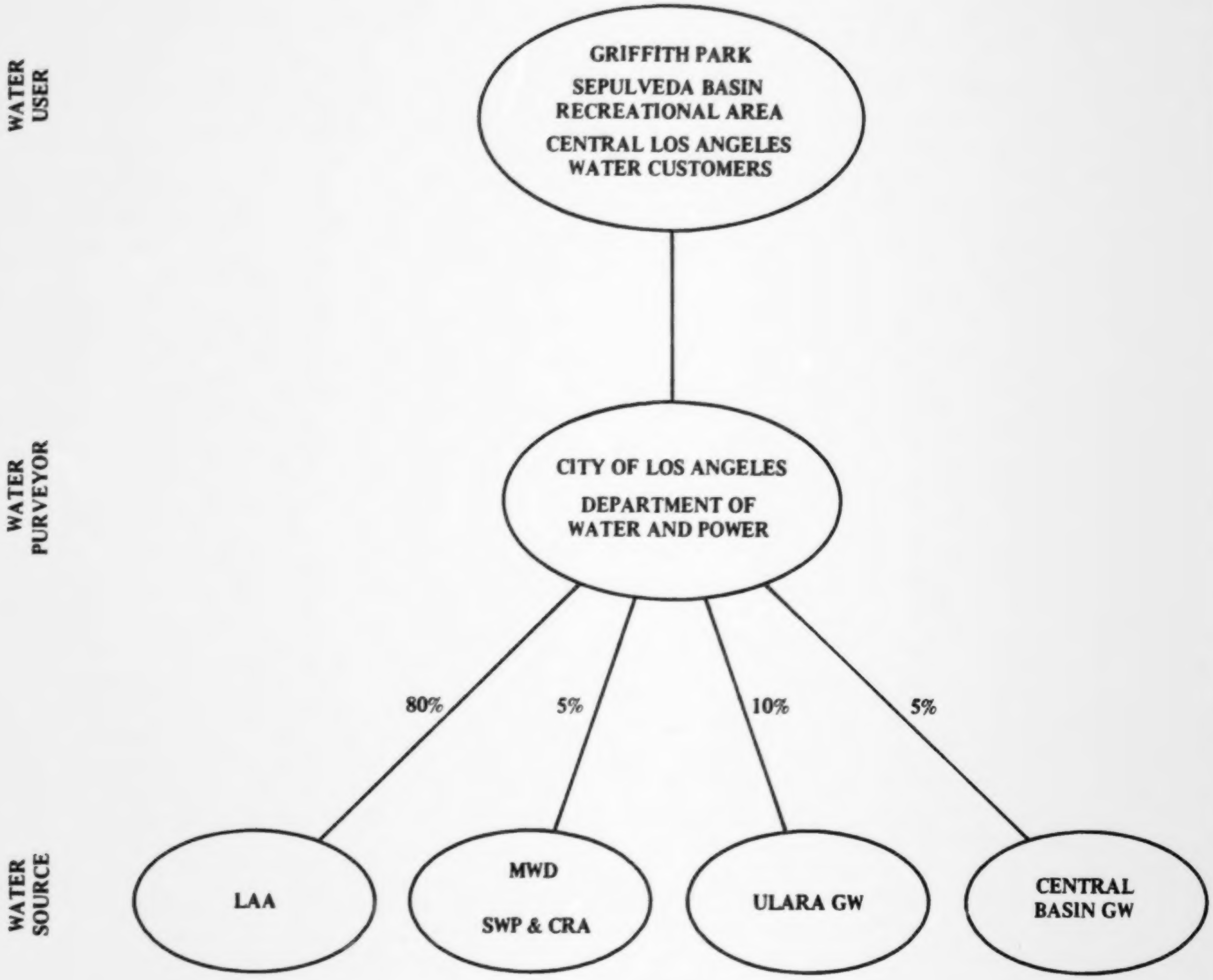
Penalty costs associated with quality deficiencies in reclaimed water compared with current sources of water available to each location and use is presented in Table 5.8.

Sewer service charges would apply only to industrial users of reclaimed water. Surcharges are levied according to wastewater loads and flows. Wastewater loads are expected to be higher when using reclaimed water, and thus, additional treatment may be required before disposal with treatment costs to be borne by the discharger. Hence, this additional cost must be considered as a penalty cost to reclaimed water. Penalty cost for sewer service could not be estimated for the analysis in this report, but should be evaluated in the final analysis of any project proposal, since this cost would be a real cost and an added financial burden to the user.

Penalty costs associated with the need for separate transmission facilities for potable water at a facility considering conversion to a nonpotable reclaimed water system could not be estimated for the analysis in this report. The variability in plumbing requirements for each specific use require a close analysis of the system requirements to estimate separate potable system costs.

figure 5.1

DOMESTIC WATER PURVEYOR AND SOURCES FOR IRRIGATION AND GROUNDWATER RECHARGE


WATER USER
GRIFFITH PARK
SEPULVEDA BASIN RECREATIONAL AREA
CENTRAL LOS ANGELES WATER CUSTOMERS
WATER PURVEYOR
CITY OF LOS ANGELES
DEPARTMENT OF WATER AND POWER
80%
5%
10%
5%
WATER SOURCE
LAA
MWD
SWP & CRA
ULARA GW
CENTRAL BASIN GW

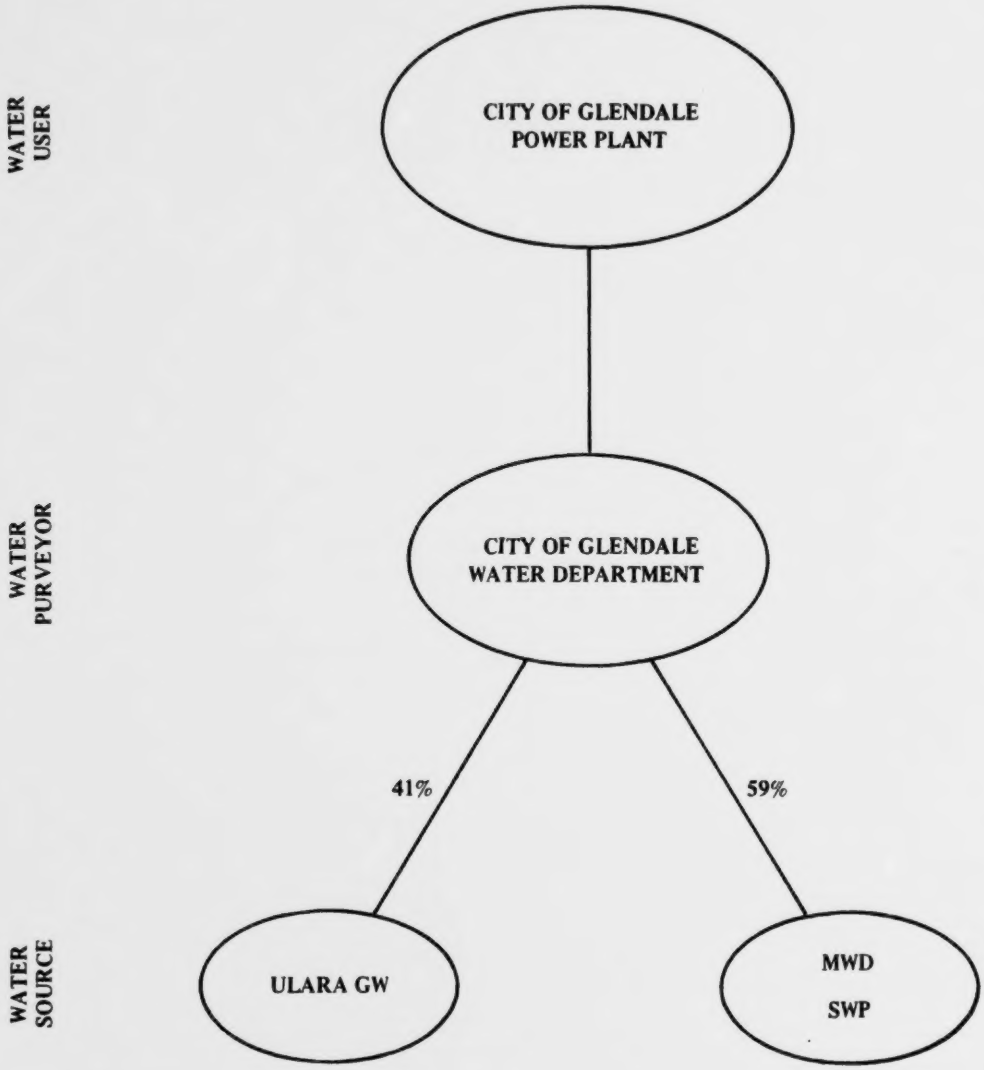
LEGEND

LAA – LOS ANGELES AQUEDUCT (OWENS VALLEY)
MWD – METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA
SWP – STATE WATER PROJECT
CRA – COLORADO RIVER AQUEDUCT
ULARA GW – UPPER LOS ANGELES RIVER AREA GROUNDWATER

100

figure 5.2

DOMESTIC WATER PURVEYOR AND SOURCES FOR CITY OF GLENDALE POWER PLANT COOLING

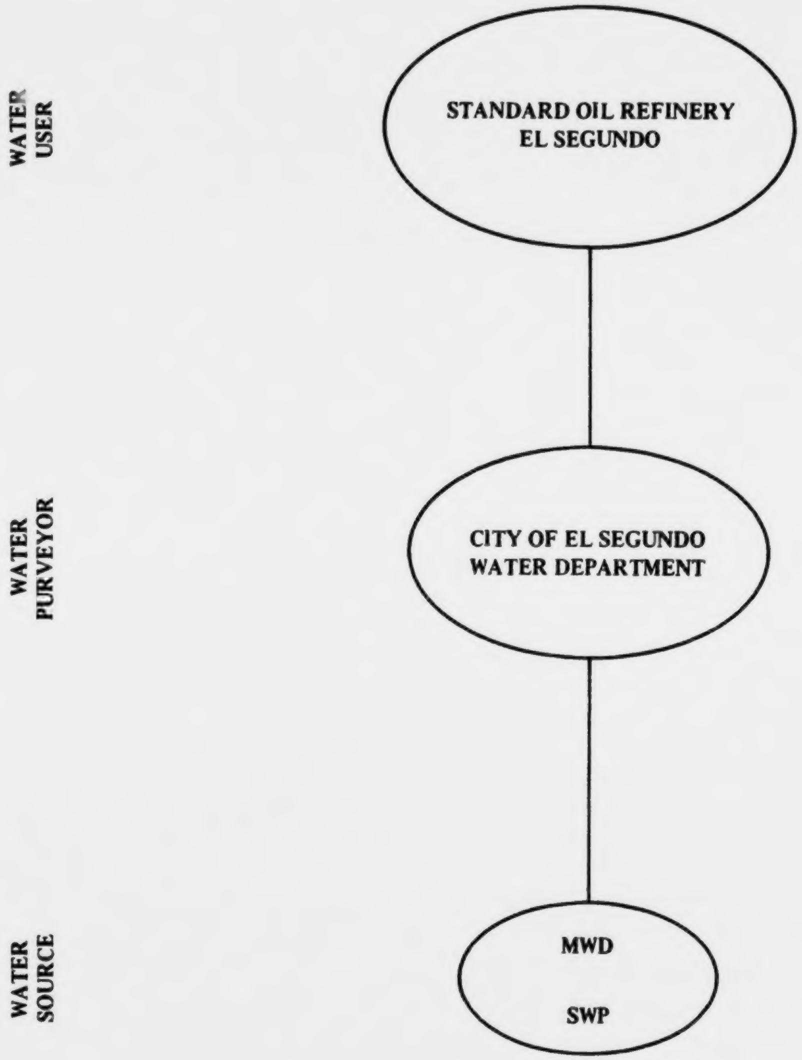

WATER USER
CITY OF GLENDALE POWER PLANT
WATER PURVEYOR
CITY OF GLENDALE WATER DEPARTMENT
41%
59%
WATER SOURCE
ULARA GW
MWD
SWP

LEGEND

ULARA GW – UPPER LOS ANGELES RIVER AREA GROUNDWATER
MWD – METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA
SWP – STATE WATER PROJECT

figure 5.3

DOMESTIC WATER PURVEYOR AND SOURCE FOR STANDARD OIL REFINERY – EL SEGUNDO


WATER USER
STANDARD OIL REFINERY
EL SEGUNDO
WATER PURVEYOR
CITY OF EL SEGUNDO
WATER DEPARTMENT
WATER SOURCE
MWD
SWP

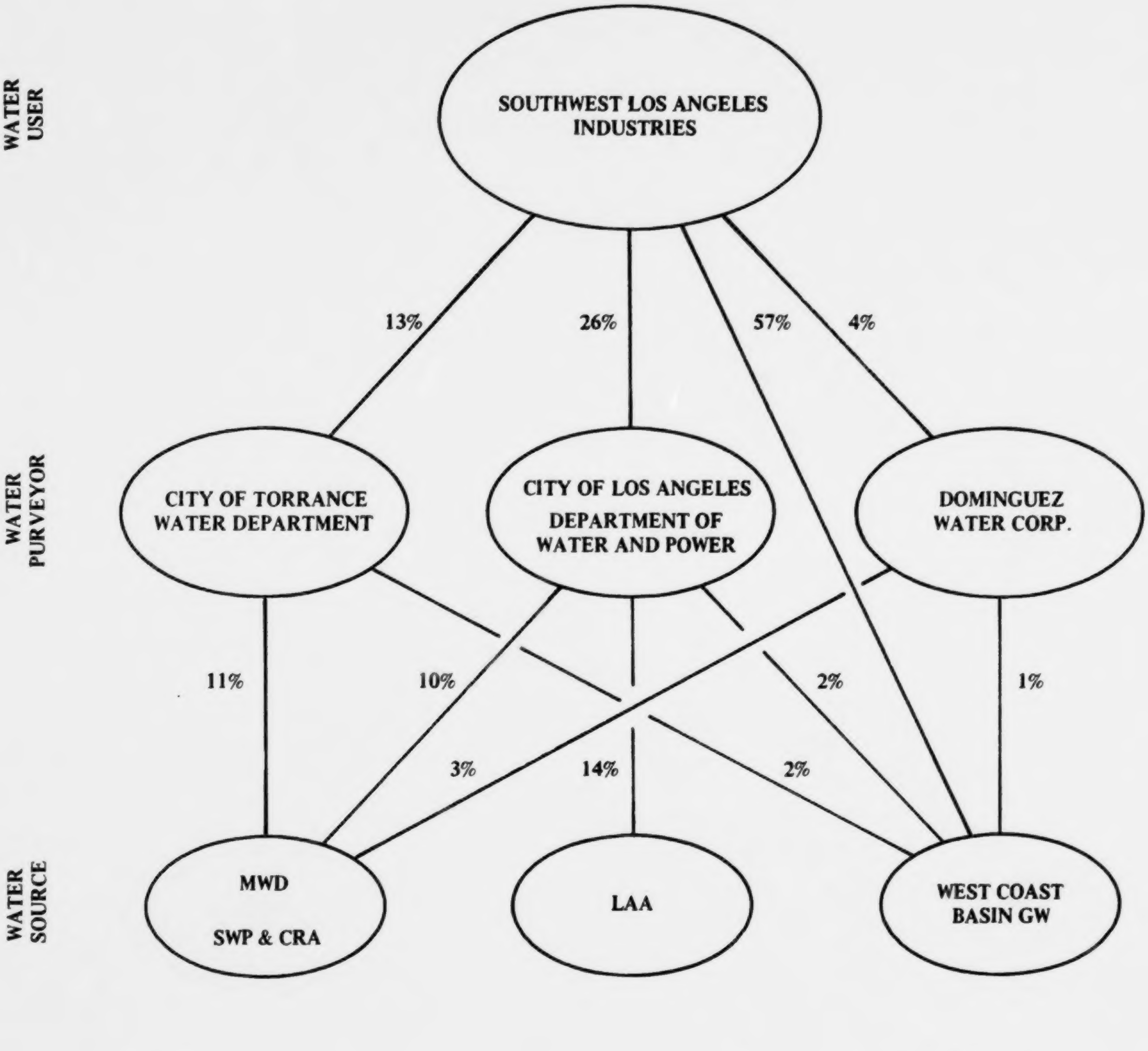
LEGEND

MWD – METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA
SWP – STATE WATER PROJECT

102

figure 5.4

DOMESTIC WATER PURVEYORS
AND SOURCES FOR
SOUTHWEST LOS ANGELES INDUSTRIES


WATER USER
SOUTHWEST LOS ANGELES INDUSTRIES
13%
26%
57%
4%
WATER PURVEYOR
CITY OF TORRANCE WATER DEPARTMENT
CITY OF LOS ANGELES DEPARTMENT OF WATER AND POWER
DOMINGUEZ WATER CORP.
11%
10%
2%
1%
3%
14%
2%
WATER SOURCE
MWD
SWP & CRA
LAA
WEST COAST BASIN GW

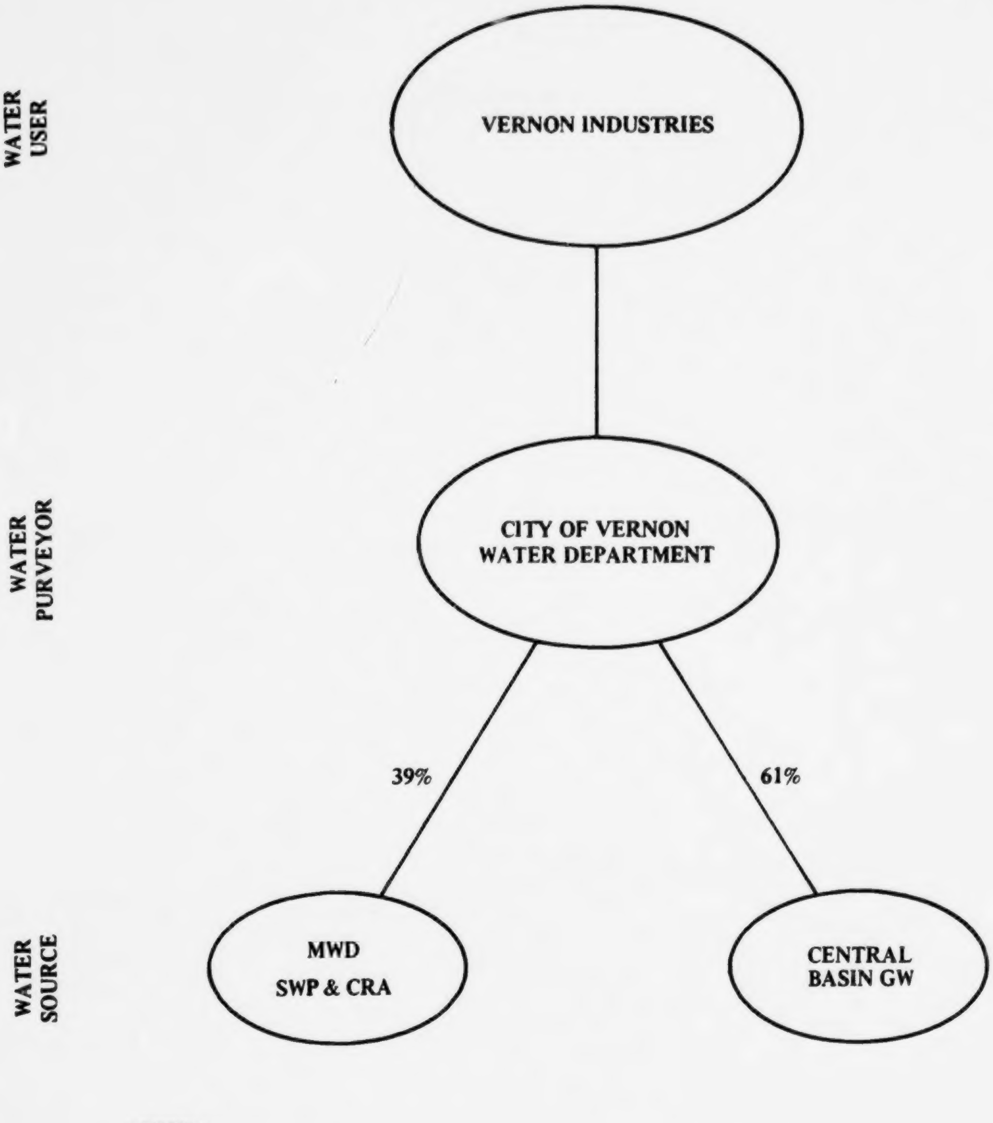
LEGEND

LAA – LOS ANGELES AQUEDUCT (OWENS VALLEY)
MWD – METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA
SWP – STATE WATER PROJECT
CRA – COLORADO RIVER AQUEDUCT

103

figure 5.5

DOMESTIC WATER PURVEYOR AND SOURCES FOR VERNON INDUSTRIES

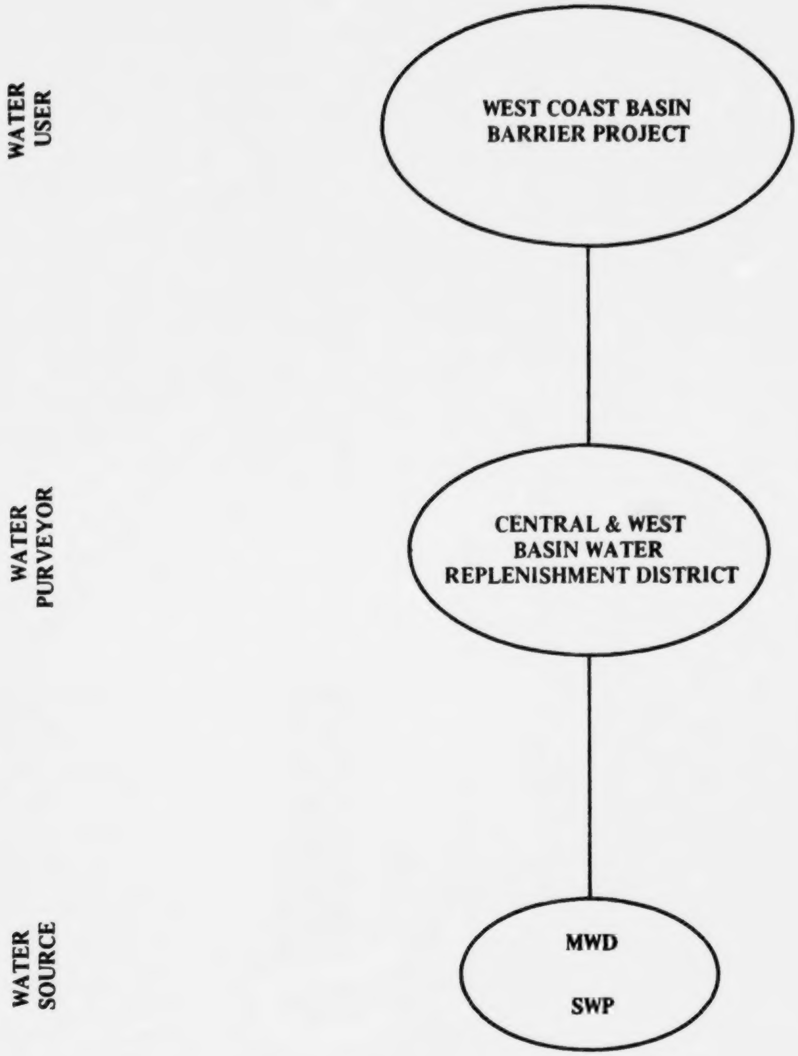

WATER USER
VERNON INDUSTRIES
WATER PURVEYOR
CITY OF VERNON WATER DEPARTMENT
39%
61%
WATER SOURCE
MWD SWP & CRA
CENTRAL BASIN GW

LEGEND

MWD – METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA
SWP – STATE WATER PROJECT
CRA – COLORADO RIVER AQUEDUCT

figure 5.6

DOMESTIC WATER PURVEYOR AND SOURCE FOR WEST COAST BASIN BARRIER PROJECT


WATER USER
WEST COAST BASIN BARRIER PROJECT
WATER PURVEYOR
CENTRAL & WEST BASIN WATER REPLENISHMENT DISTRICT
WATER SOURCE
MWD
SWP

LEGEND

MWD – METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA
SWP – STATE WATER PROJECT

TABLE 5.1

DOMESTIC WATER SERVICES INTERRUPTED BY PROPOSED RECLAIMED WATER USES

Reclaimed Water System Alt. No.	Total Quantity Reclaimed in the Period 1980–2000	LOCAL AGENCIES AND DOMESTIC WATER SERVICE INTERRUPTED BY USE OF RECLAIMED WATER																Total Quantity of Domestic Water Service Interrupted by Reclaimed Water Use in the Period 1980–2000		
		CITY OF LA		SWLA		CITY OF TORRANCE		DOMINGUEZ WATER CORP.		CITY OF VERNON		CITY OF EL SEGUNDO		C&WBWRD		CITY OF GLENDALE				
		GW	MWD	GW	MWD	GW	MWD	GW	MWD	GW	MWD	GW	MWD	GW	MWD	GW	MWD	GW	MWD	Total
	MAF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	MAF	MAF	MAF
1	1.56	8,064	976,000	287,280	0	11,088	54,432	7,056	13,104	0	0	0	134,400	0	0	0	67,200	.313	1.25	1.56
2	1.95	8,064	976,000	287,280	0	11,088	54,432	7,056	13,104	0	0	0	134,400	0	392,000	0	67,200	.313	1.64	1.95
3	1.93	13,978	1,066,000	497,952	0	19,219	94,348	12,230	22,713	0	0	0	134,400	0	0	0	67,200	.543	1.39	1.93
4	2.32	13,978	1,066,000	497,952	0	19,219	94,348	12,230	22,713	0	0	0	134,400	0	392,000	0	67,200	.543	1.78	2.32
5	2.26	13,978	1,066,000	497,952	0	19,219	94,348	12,230	22,713	204,960	13,140	0	134,400	0	0	0	67,200	.748	1.51	2.26
6	2.66	13,978	1,066,000	497,952	0	19,219	94,348	12,230	22,713	204,960	13,140	0	134,400	0	392,000	0	67,200	.748	1.91	2.66

NOTE: These quantities have been estimated from past records and are based on averages throughout purveyors service area which may not directly apply to the service interrupted by each particular reclaimed water user. Additional information is needed to confirm the data in this table.

LEGEND:
MAF – Million Acre Feet
AF – Acre Feet
GW – Groundwater
MWD – Metropolitan Water District of Southern California sources of water (including State and Colorado River water).
SWLA – Southwest Los Angeles Industries use of groundwater from their own wells.
C&WBWRD – Central and West Basin Water Replenishment District purchased from MWD.

TABLE 5.2

TOTAL ESTIMATED PAYMENTS BY POTENTIAL RECLAIMED WATER USERS FOR PURCHASE OF DOMESTIC WATER FROM LOCAL WATER PURVEYORS

		TOTAL ESTIMATED PAYMENTS FOR DOMESTIC WATER FOR THE PERIOD 1980–2000 (millions 1975 Dollars)							
Reclaimed Water System Alt. No.	**Potential Quantity of Reclaimed Water to be Used (1980–2000) (MAF)**	**Total**	**SWLA Industries**	**Vernon Industries**	**Standard Oil Refinery**	**Glendale Steam Plant**	**SFV Irrigation**	**SFV Groundwater Recharge**	**WCBBP**
1	1.56	164.5	52	0	16	6	49	41.5	0
2	1.95	189.1	52	0	16	6	49	41.5	24.6
3	1.93	202.5	90	0	16	6	49	41.5	0
4	2.32	227.1	90	0	16	6	49	41.5	24.6
5	2.26	224.5	90	42	16	6	49	41.5	0
6	2.66	269.1	90	42	16	6	49	41.5	24.6

NOTE:

These payments are in millions of dollars estimated for the 20-year study period. They are based on an assumed revision in the MWD pricing structure being studied by their staff which calls for reduced reliance on tax support (not approved by Board), and on local water purveyors fixed costs, discounted to year 1975. This analysis is very dependant on these basis, and thus additional analysis would be necessary if they do not develop.

TABLE 5.3

TOTAL ESTIMATED PAYMENTS BY POTENTIAL RECLAIMED WATER USERS FOR PURCHASE OF RECLAIMED WATER FROM LOCAL WATER PURVEYOR

Reclaimed Water System Alt. No.	Potential Quantity of Reclaimed Water to be Used (1980–2000) (MAF)	TOTAL ESTIMATED PAYMENTS FOR THE PERIOD 1980–2000 (Millions 1975 Dollars)			
		Domestic Water Payment[1]	Penalty Costs[2] B/E[3]	Sale of Groundwater SWLA[4]	Net Payment[5] B/E[3]
1	1.56	164.5	26.9/23.9	9	146.6/149.6
2	1.95	189.1	34.0/31.0	9	164.1/167.1
3	1.93	202.5	36.5/31.3	16	182.0/187.2
4	2.32	227.1	43.6/38.4	16	199.5/204.7
5	2.26	244.5	43.6/41.5	16	216.9/219.0
6	2.66	269.1	50.7/48.6	16	234.4/236.5

[1] See Table 5.2

[2] See Table 5.8

[3] Refers to Wastewater Management Plan Alternatives B and E.

[4] Based on the difference in the cost to use groundwater and the price of MWD supplies times the quantity of groundwater production interrupted by using reclaimed water (Table 5.1).

[5] Net result of payment for domestic water less penalty for use of reclaimed water plus benefit from sale of groundwater rights.

TABLE 5.4

TOTAL ESTIMATED PAYMENTS BY WATER PURVEYORS TO RECLAIMED WATER PRODUCER

			TOTAL ESTIMATED PAYMENTS FOR THE PERIOD 1980–2000 (Millions 1975 Dollars)			
Reclaimed Water System Alt. No.	Wastewater Management Plan Alternative	Potential Quantity of Reclaimed Water to be Used (1980–2000) (MAF)	Payments by Users for Reclaimed Water[1]	Sales of Purveyors' Groundwater[2]	Purveyors' Fixed Costs[3]	Net Payment to Reclaimed Water Producer[4]
1	B	1.56	146.6	0.9	27.0	120.5
	E		149.6			123.5
2	B	1.95	164.1	0.9	27.0	138.0
	E		167.1			141.0
3	B	1.93	182.0	1.5	33.7	150.0
	E		187.2			155.0
4	B	2.32	199.5	1.5	33.7	167.0
	E		204.7			172.5
5	B	2.26	216.9	8.2	52.3	173.0
	E		219.0			175.0
6	B	2.66	234.4	8.2	52.3	190.0
	E		236.5			192.0

[1] See Table 5.3

[2] Based on the difference in the cost to use groundwater and the price of MWD supplies times the quantity of groundwater production interrupted by using reclaimed water (Table 5.1).

[3] These estimated costs are the fixed costs of the purveyor associated with assurance to the user that domestic water supplies would be available and includes costs which must be paid even if the supplies are not used. See text for explanation of how these costs are estimated.

[4] Net result of payment for reclaimed water by users plus sales of groundwater rights less purveyors' fixed costs.

TABLE 5.5

TOTAL ESTIMATED RECLAIMED WATER PRODUCER REVENUE REQUIREMENTS

Reclaimed Water System Alt. No.	Wastewater Management Plan Alternative	Potential Quantity of Reclaimed Water to be Used[1] (1980–2000) (MAF)	TOTAL ESTIMATED PAYMENTS FOR THE PERIOD 1980–2000 (Millions 1975 Dollars)			
			Payments for Reclaimed Water to Producer[2]	Potential Quantity of Water Reclaimed[1] (1980–2000)(MAF)	Net Cost to Producer for Reclaimed Water[3]	Reclaimed Water Revenue Required[4]
1	B–4	1.56	120.5	1.76	217.9	97.4
	E–1		123.5		200.4	76.9
	E–2				198.0	74.5
2	B–4	1.95	138.0	2.15	289.6	151.6
	E–1		141.0		268.4	127.4
	E–2				261.2	120.2
3	B–4	1.93	150.0	2.13	280.5	130.5
	E–1		155.0		246.0	90.0
	E–2				243.5	88.5
4	B–4	2.32	167.0	2.52	355.5	188.5
	E–1		172.5		313.9	141.4
	E–2				306.9	134.4
5	B–4	2.26	173.0	2.46	342.3	169.3
	E–1		175.0		273.0	98.0
	E–2				270.6	95.6
6	B–4	2.66	190.0	2.86	409.7	219.7
	E–1		192.0		341.0	149.0
	E–2				334.0	142.0

[1] The difference in these quantities is a result of approximately 200,000 acre feet of water reclaimed and stored in the San Fernando Valley Groundwater Basin for use beyond Year 2000.

[2] See Table 5.4

[3] Based on information developed in Chapter 4. Salvage Value based on straight line depreciation with assumptions presented in text.

[4] Net result of payment for reclaimed water from purveyor less cost to produce reclaimed water.

TABLE 5.6

TOTAL ESTIMATED REVENUE REQUIREMENTS FOR PRODUCTION AND USE OF RECLAIMED WATER

Reclaimed Water System Alternative No.	Wastewater Management Plan Alternative	Total Potential Water Sources Developed through Reclamation (AF)	TOTAL ESTIMATED PAYMENTS FOR THE PERIOD 1980–2000 (Millions 1975 Dollars)		
			Reclaimed Water Producer Net Revenue[1]	MWD Fixed Costs[2]	Revenue Requirements[3]
1	B–4	1.76	97.4	99.6	197
	E–1		76.9		176
	E–2		74.5		174
2	B–4	2.15	151.6	105.7	257
	E–1		127.4		233
	B–2		120.2		226
3	B–4	2.13	130.5	109.3	240
	E–1		91.0		200
	E–2		88.5		198
4	B–4	2.52	188.5	131.4	320
	E–1		141.4		273
	E–2		134.4		266
5	B–4	2.46	169.3	126.8	296
	E–1		98.0		225
	E–2		95.6		222
6	B–4	2.86	219.7	148.6	368
	E–1		149.0		298
	E–2		142.0		291

[1] See Table 5.5.

[2] Based on fixed costs of MWD associated with assurance to member agencies that domestic water supplies would be available and include costs which must be paid even if the supplies are not used. See text for explanation of how these costs are estimated.

[3] Net result of reclaimed water producer's net revenues plus MWD's fixed costs. These revenue requirements are needed to support the quantity of reclaimed water proposed to be used in exchange for the reduction in demand of MWD supplies.

TABLE 5.7

ASSUMPTIONS FOR ESTIMATING REVENUE EXCHANGES IN FINANCIAL ANALYSIS

1. Future distribution of domestic source waters serving each potential reclaimed water user will be through the same water purveyor and in the same percentage as in 1975. That is, the split between surface and groundwater supplies served to each user will remain constant if a domestic water service is maintained.

2. Metropolitan Water District of Southern California (MWD) projected water rates are based on the following. (Note: This information has been developed by MWD staff, but not adopted by their Board.)

   a) Adoption of a water rate policy by 1980 including:

      1) a commodity rate that is equally applicable to all uses except agriculture;

      2) a treatment surcharge that will recover costs of treatment; and

      3) a peaking rate with approximate average peaking factors of
         1.2 for municipal and industrial uses
         1.0 for groundwater replenishment through barrier use
         0.42 for groundwater replenishment through spreading and blending with reclaimed water.

   b) Increased power costs for State water beginning 1983 will be "feathered" into the local water rates by collection and investment of excess revenues beginning 1979.

   c) Present worth determination of water rates based on assumed escalation of all costs presented in MWD studies at 5 percent per year. This escalation at 5 percent per year assumed to apply to commodity rates, treatment surcharge and peaking rates.

   d) MWD costs allocated to taxpayers as indicated in MWD staff's water rate studies.

3. The fixed cost of local water purveyors for supplying domestic water is the difference between the average cost of their source of supply in 1975 and their average charge to the user. This fixed cost was determined for each water purveyor involved in the development of reclaimed water. The present worth of the fixed cost was based on 1975 costs being constant throughout the period 1980 through 2000 with the rate of inflation equalling the rate of return.

4. The groundwater rights are sold annually for a price equal to the difference between the cost to use the groundwater and the price charged by MWD for municipal and industrial water.

5. The cost for water for any water user who converts to the use of reclaimed water is the same as it would have been for the use of domestic water. That is, the average expenses paid by the water user associated with the *use* of domestic water would not change when using reclaimed water.

TABLE 5.7 (Continued)

6. The present worth of the cost to produce reclaimed water is the present worth of the capital expenditures less the salvage value in the year 2000, plus the sum of the variable costs through year 2000. The assumptions related to the capital costs are presented in Chapter 4. The salvage value for the reclamation facilities for the SWLA industries in year 2000 is zero (due to the questionable life of that market). The salvage value of all other facilities is based on a straight line depreciation and an average life of 40 years. The variable cost includes the operations and maintenance costs as presented in Chapter 4, plus recovery of a 40 percent contingency to allow for risk of investment.

7. The MWD fixed costs (associated with the domestic water service interrupted by the development of reclaimed water) include only costs assigned to water users for MWD capital and fixed or limited operations and maintenance costs obligated to their system and their portion of the State Water Project. These fixed costs do not include the incremental or variable costs associated with transporting, treating, and delivering the water (primarily energy).

TABLE 5.8

PENALTY COSTS OF USING RECLAIMED WATER

POTENTIAL RECLAIMED WATER USE		CURRENT SOURCE QUALITY		WASTEWATER MANAGEMENT PLAN ALTERNATIVE[4]	SOURCE RECLAIMED WATER QUALITY		PENALTY COST[1] OF RECLAIMED WATER $/AF
Location	Type	TDS[2]	TH[3]		TDS[2]	TH[3]	
Griffith Park	Irrigation	390	195	B/E	600	223	16
Glendale Steam Plant	Cooling	340	207	B/E	600		15
Sepulveda Basin Recreational Area	Irrigation	180	90	B/E	600	223	38
Headworks/Tujunga Spreading Grounds	Groundwater Replenishment–Spreading	500	250	B/E	500	95	0
Standard Oil Refinery El Segundo	Industrial	274	139	B/E	750	180	26
Southwest Los Angeles Industries	Industrial	329	149	B	750	180	26
				E	650	130	20
Vernon Industries	Industrial	374	191	B	750	180	21
				E	650	130	15
West Coast Basin Barrier Project	Groundwater Replenishment–Injection	274	139	B/E	750	180	18

[1] Derived from Sanitation Districts of Los Angeles County, *Joint Outfall System Facilities Plan, Draft EIR/EIS*, Appendix 6, Chapter IV, pp. 10 – 16 (1976).

[2] Total Dissolved Solids in milligrams per liter.

[3] Total Hardness in milligrams per liter.

[4] Refers to designation in the City of Los Angeles Facilities Plan. "B" is upstream/coastal treatment and "E" is maximum reclamation.

TABLE 5.9

FINANCIAL IMPACT OF ALTERNATIVE WASTEWATER MANAGEMENT PLANS ON WATER RECLAMATION

Reclaimed Water Use*	**Change in System**	**Increased Revenues Required to Support Water Reclamation with Wastewater Reclamation Plan Alternative B over E** *(Present Worth in Millions 1975 Dollars for the Period 1980 thru 2000)*
Industrial – *Southwest Los Angeles Industries*	*Increased Use from 0 to 30 mgd*	22
Industrial – *Southwest Los Angeles Industries*	*Increased Use from 30 to 52 mgd*	41
Industrial – *Vernon Industries*	*Increased Use from 0 to 20 mgd*	72.5
Seawater Intrusion Barrier – *West Coast Basin Barrier Project*	*Increased Use from 0 to 35 mgd*	73.5

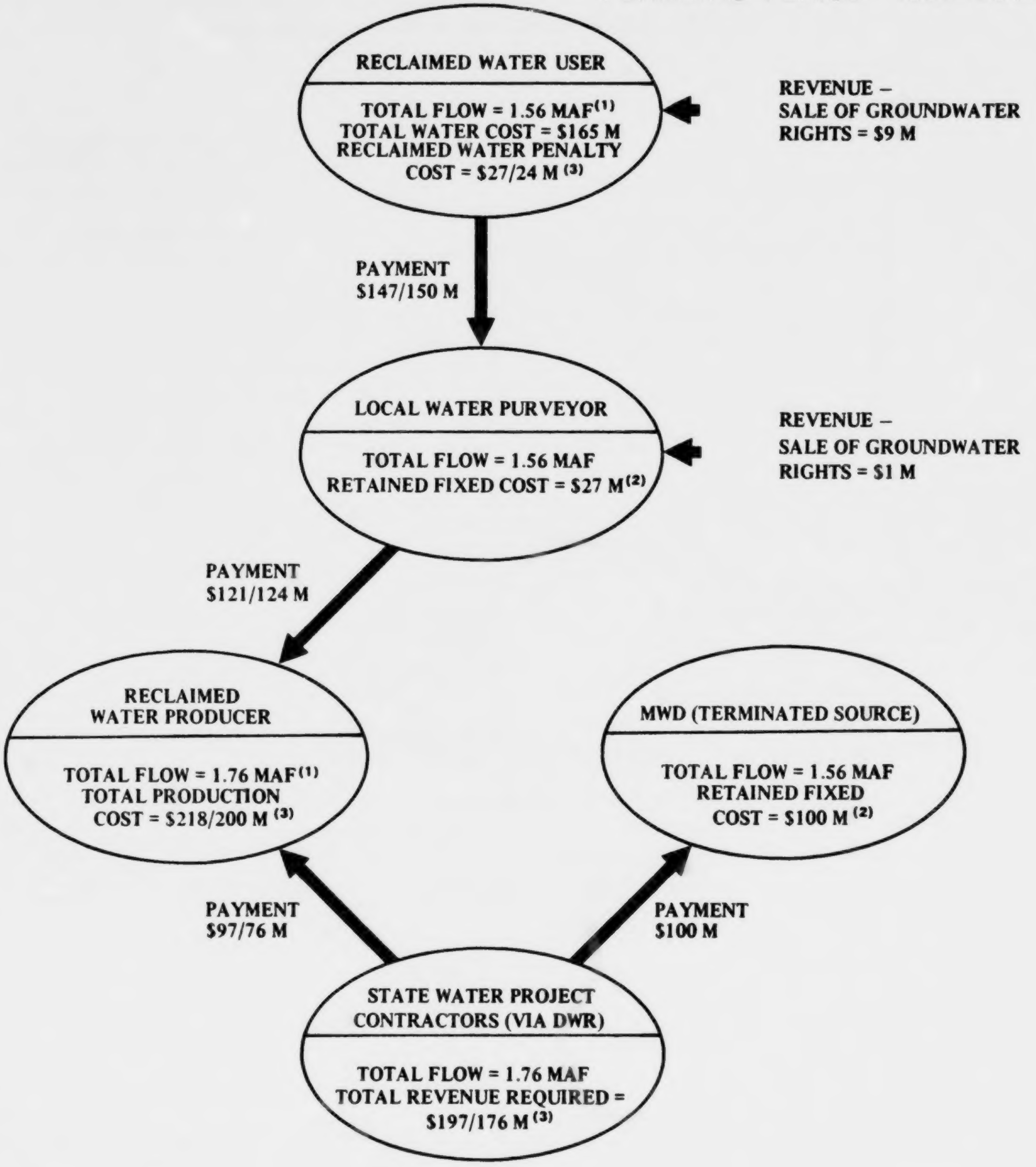
*The total reclaimed water use includes the uses presented below *plus* the uses identified in this table. These uses were changed to vary the potential level of water reclamation.

Sepulveda Basin Recreational Area	9 mgd
Griffith Park	5 mgd
Glendale Steam Plant	3 mgd
Headworks/Tujunga Spreading Grounds	45 mgd
Standard Oil Refinery	8 mgd

figure 5.7

CASH FLOW CHART FOR RECLAIMED WATER FINANCIAL ANALYSIS – SYSTEM NO. 1

PLANNING PERIOD: 1980–2000



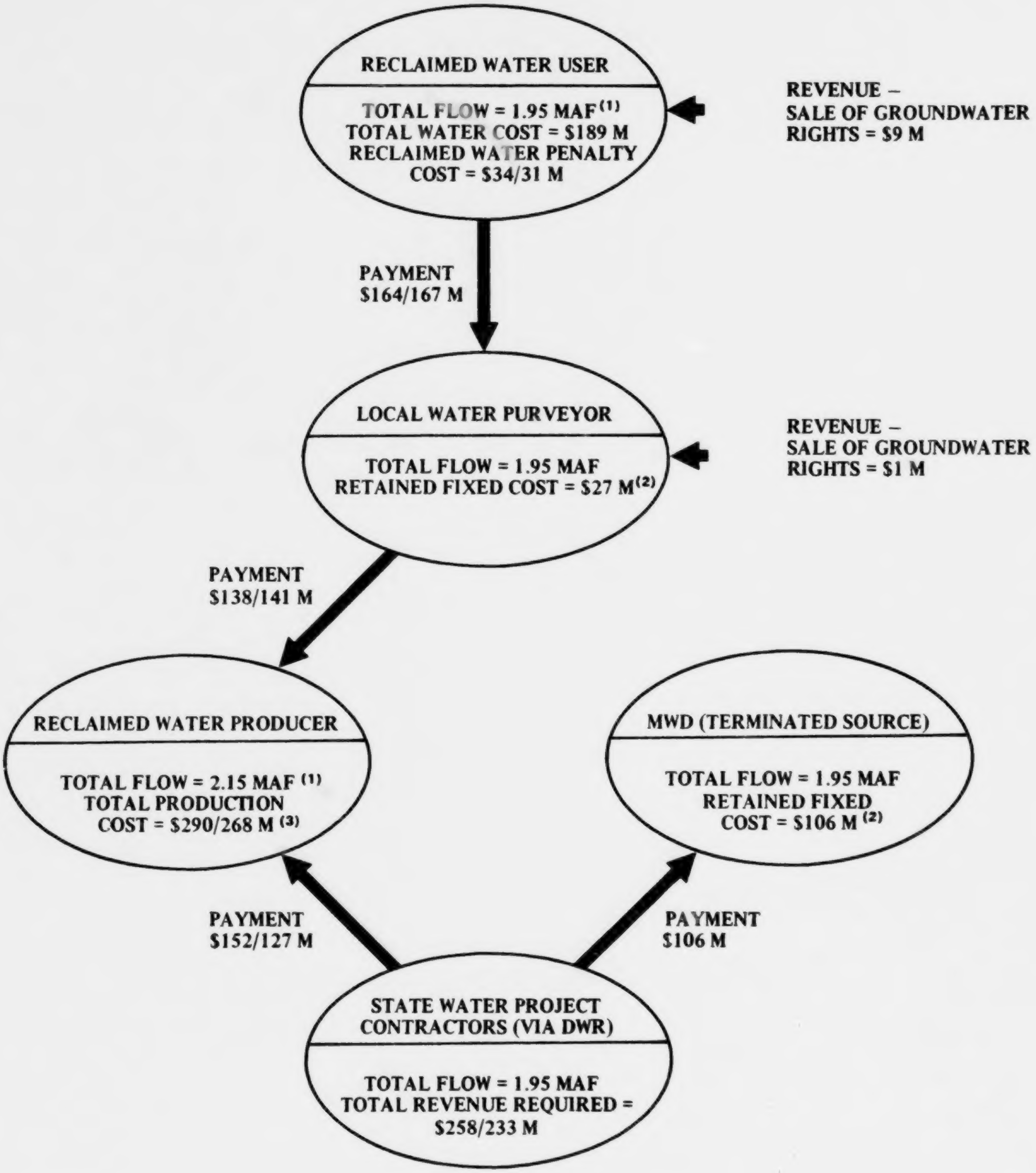
RECLAIMED WATER USER
TOTAL FLOW = 1.56 MAF(1)
TOTAL WATER COST = $165 M
RECLAIMED WATER PENALTY COST = $27/24 M (3)
REVENUE – SALE OF GROUNDWATER RIGHTS = $9 M
PAYMENT $147/150 M
LOCAL WATER PURVEYOR
TOTAL FLOW = 1.56 MAF
RETAINED FIXED COST = $27 M(2)
REVENUE – SALE OF GROUNDWATER RIGHTS = $1 M
PAYMENT $121/124 M
RECLAIMED WATER PRODUCER
TOTAL FLOW = 1.76 MAF(1)
TOTAL PRODUCTION COST = $218/200 M (3)
MWD (TERMINATED SOURCE)
TOTAL FLOW = 1.56 MAF
RETAINED FIXED COST = $100 M (2)
PAYMENT $97/76 M
PAYMENT $100 M
STATE WATER PROJECT CONTRACTORS (VIA DWR)
TOTAL FLOW = 1.76 MAF
TOTAL REVENUE REQUIRED = $197/176 M (3)

NOTES:
1. Amount of reclaimed water used is 0.2 MAF less than the amount produced due to excess groundwater recharge.
2. Retained fixed cost is the amount of money required due to interruption of existing domestic water service.
3. Costs and revenues are 1975 Present Worth dollars for Alternative B-4/Alternative E-1 over the planning period (1980 – 2000).

figure 5.8

CASH FLOW CHART FOR RECLAIMED WATER FINANCIAL ANALYSIS—SYSTEM NO. 2

PLANNING PERIOD: 1980–2000

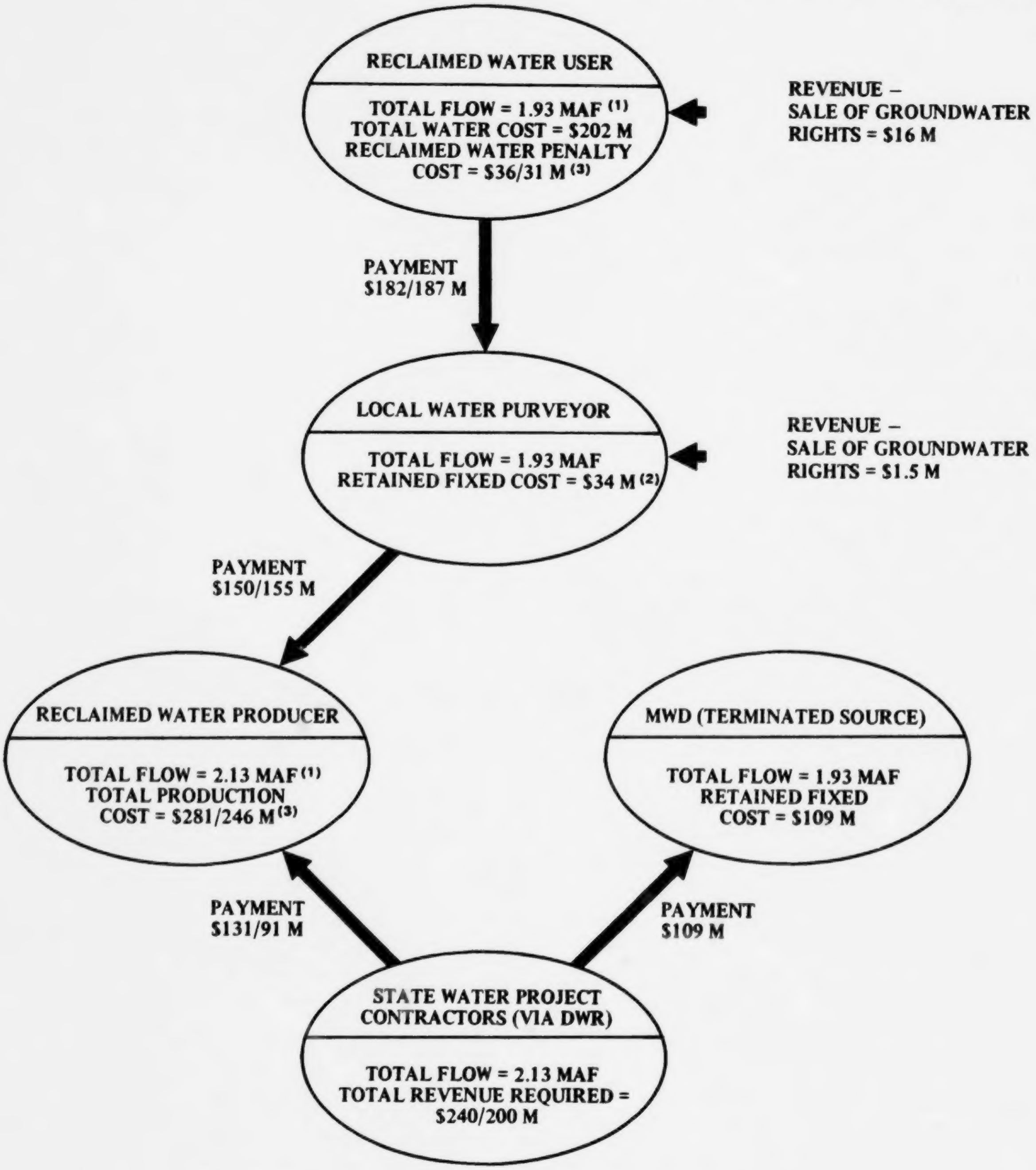

RECLAIMED WATER USER
TOTAL FLOW = 1.95 MAF (1)
TOTAL WATER COST = $189 M
RECLAIMED WATER PENALTY COST = $34/31 M
REVENUE – SALE OF GROUNDWATER RIGHTS = $9 M
PAYMENT $164/167 M
LOCAL WATER PURVEYOR
TOTAL FLOW = 1.95 MAF
RETAINED FIXED COST = $27 M (2)
REVENUE – SALE OF GROUNDWATER RIGHTS = $1 M
PAYMENT $138/141 M
RECLAIMED WATER PRODUCER
TOTAL FLOW = 2.15 MAF (1)
TOTAL PRODUCTION COST = $290/268 M (3)
MWD (TERMINATED SOURCE)
TOTAL FLOW = 1.95 MAF
RETAINED FIXED COST = $106 M (2)
PAYMENT $152/127 M
PAYMENT $106 M
STATE WATER PROJECT CONTRACTORS (VIA DWR)
TOTAL FLOW = 1.95 MAF
TOTAL REVENUE REQUIRED = $258/233 M

NOTES:
1. Amount of reclaimed water used is 0.2 MAF less than the amount produced due to excess groundwater recharge.
2. Retained fixed cost is the amount of money required due to interruption of existing domestic water service.
3. Costs and revenues are 1975 Present Worth dollars for Alternative B-4/Alternative E-1 over the planning period (1980 – 2000).

figure 5.9

CASH FLOW CHART FOR RECLAIMED WATER FINANCIAL ANALYSIS – SYSTEM NO. 3

PLANNING PERIOD: 1980–2000

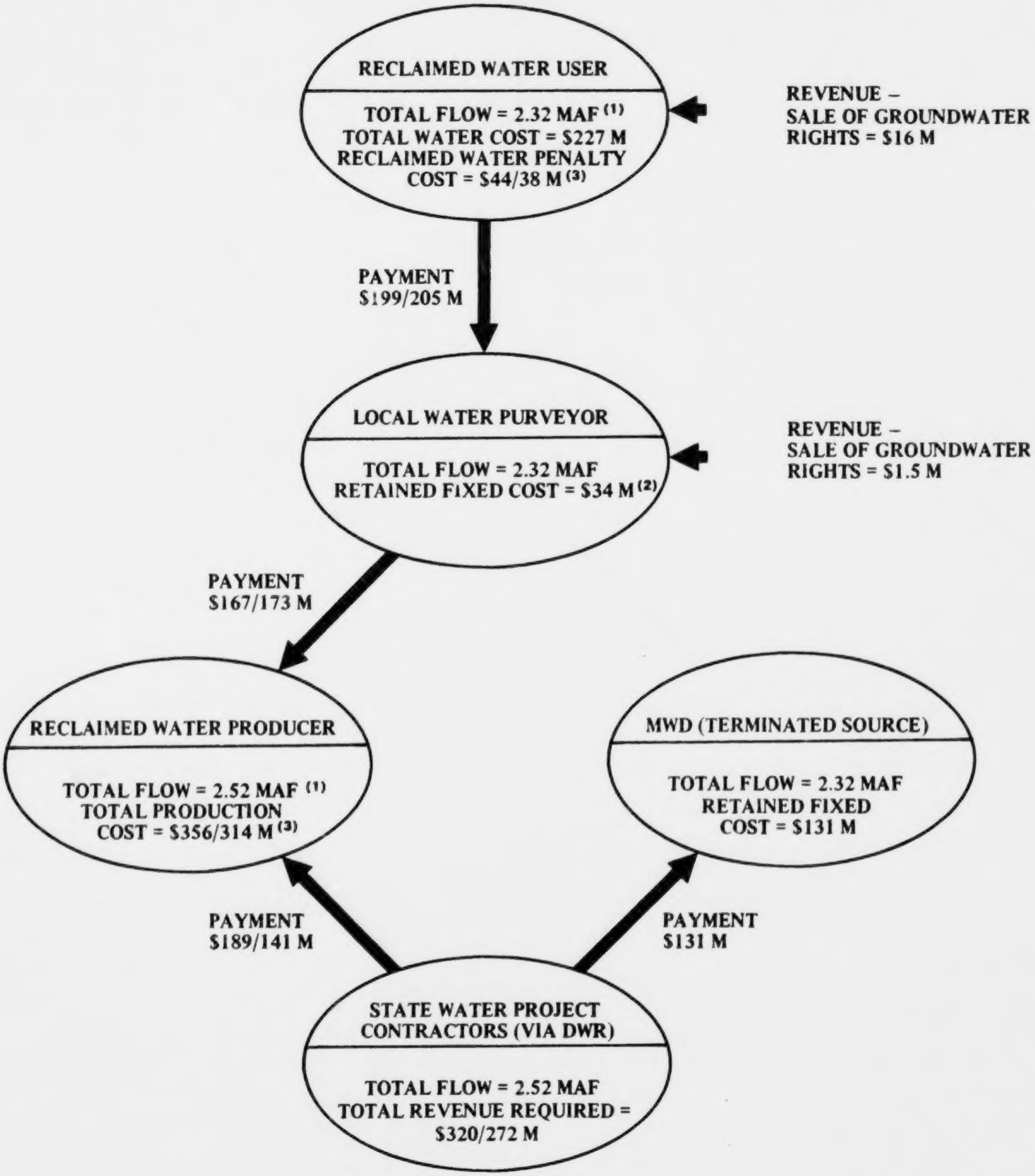

RECLAIMED WATER USER
TOTAL FLOW = 1.93 MAF (1)
TOTAL WATER COST = $202 M
RECLAIMED WATER PENALTY COST = $36/31 M (3)
REVENUE – SALE OF GROUNDWATER RIGHTS = $16 M
PAYMENT $182/187 M
LOCAL WATER PURVEYOR
TOTAL FLOW = 1.93 MAF
RETAINED FIXED COST = $34 M (2)
REVENUE – SALE OF GROUNDWATER RIGHTS = $1.5 M
PAYMENT $150/155 M
RECLAIMED WATER PRODUCER
TOTAL FLOW = 2.13 MAF (1)
TOTAL PRODUCTION COST = $281/246 M (3)
MWD (TERMINATED SOURCE)
TOTAL FLOW = 1.93 MAF
RETAINED FIXED COST = $109 M
PAYMENT $131/91 M
PAYMENT $109 M
STATE WATER PROJECT CONTRACTORS (VIA DWR)
TOTAL FLOW = 2.13 MAF
TOTAL REVENUE REQUIRED = $240/200 M

NOTES:
1. Amount of reclaimed water used is 0.2 MAF less than the amount produced due to excess groundwater recharge.
2. Retained fixed cost is the amount of money required due to interruption of existing domestic water service.
3. Costs and revenues are 1975 Present Worth dollars for Alternative B-4/Alternative E-1 over the planning period (1980 – 2000).

figure 5.10

CASH FLOW CHART FOR RECLAIMED WATER FINANCIAL ANALYSIS—SYSTEM NO. 4

PLANNING PERIOD: 1980–2000

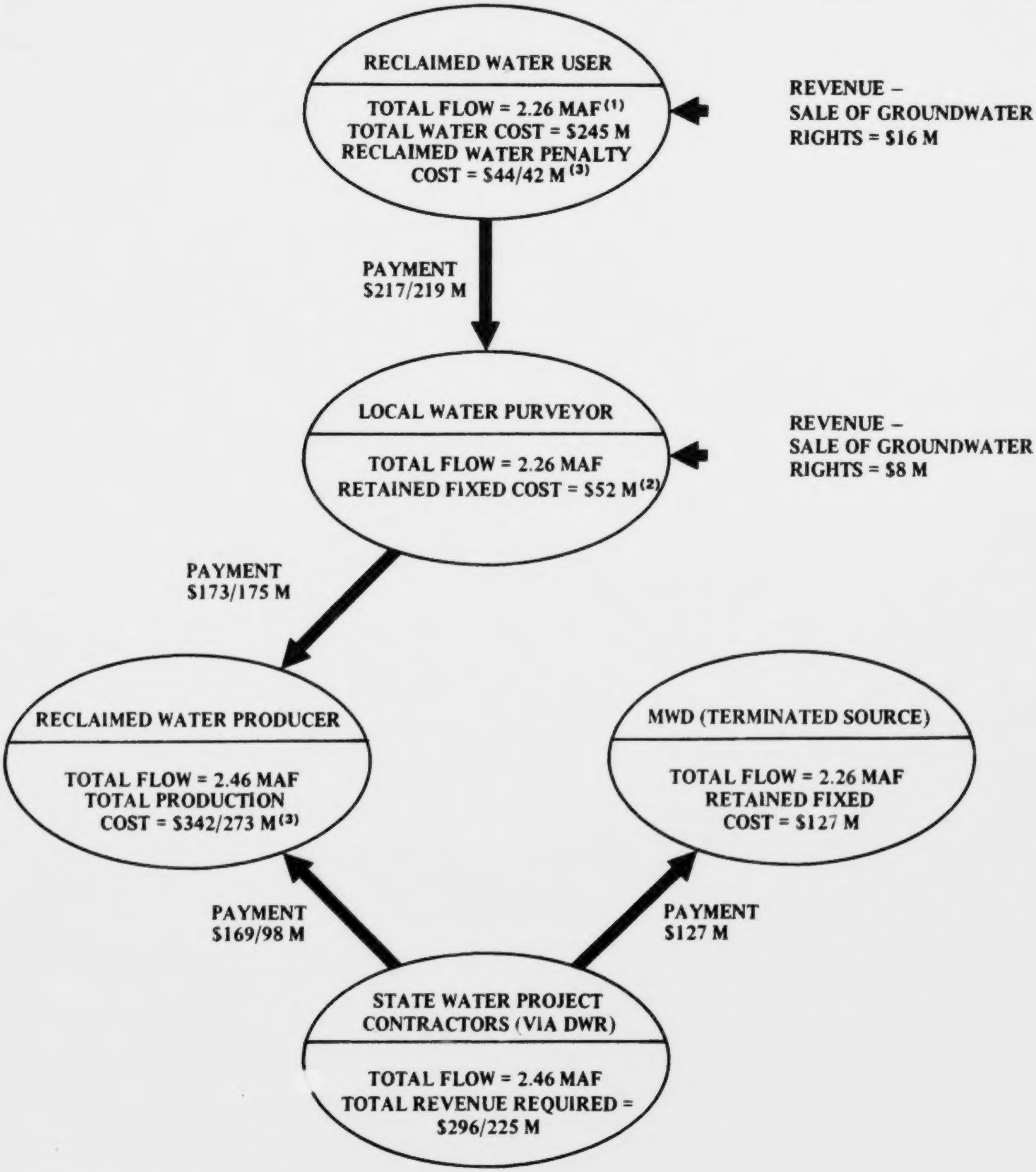

RECLAIMED WATER USER
TOTAL FLOW = 2.32 MAF (1)
TOTAL WATER COST = $227 M
RECLAIMED WATER PENALTY COST = $44/38 M (3)
REVENUE – SALE OF GROUNDWATER RIGHTS = $16 M
PAYMENT $199/205 M
LOCAL WATER PURVEYOR
TOTAL FLOW = 2.32 MAF
RETAINED FIXED COST = $34 M (2)
REVENUE – SALE OF GROUNDWATER RIGHTS = $1.5 M
PAYMENT $167/173 M
RECLAIMED WATER PRODUCER
TOTAL FLOW = 2.52 MAF (1)
TOTAL PRODUCTION COST = $356/314 M (3)
MWD (TERMINATED SOURCE)
TOTAL FLOW = 2.32 MAF
RETAINED FIXED COST = $131 M
PAYMENT $189/141 M
PAYMENT $131 M
STATE WATER PROJECT CONTRACTORS (VIA DWR)
TOTAL FLOW = 2.52 MAF
TOTAL REVENUE REQUIRED = $320/272 M

NOTES:
1. Amount of reclaimed water used is 0.2 MAF less than the amount produced due to excess groundwater recharge.
2. Retained fixed cost is the amount of money required due to interruption of existing domestic water service.
3. Costs and revenues are 1975 Present Worth dollars for Alternative B-4/Alternative E-1 over the planning period (1980 – 2000).

figure 5.11

CASH FLOW CHART FOR RECLAIMED WATER FINANCIAL ANALYSIS—SYSTEM NO. 5

PLANNING PERIOD: 1980–2000

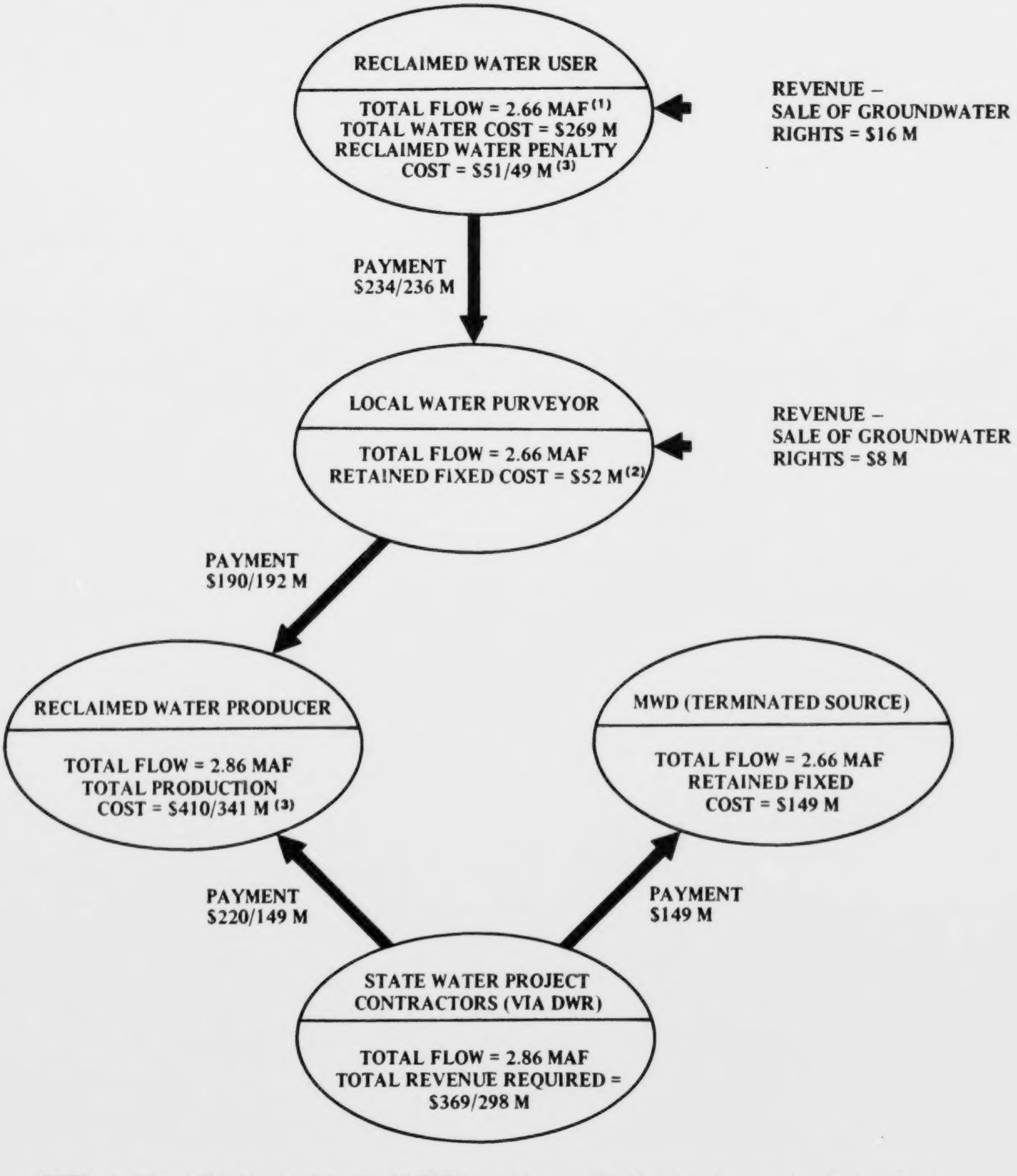

RECLAIMED WATER USER
TOTAL FLOW = 2.26 MAF (1)
TOTAL WATER COST = $245 M
RECLAIMED WATER PENALTY COST = $44/42 M (3)
REVENUE – SALE OF GROUNDWATER RIGHTS = $16 M
PAYMENT $217/219 M
LOCAL WATER PURVEYOR
TOTAL FLOW = 2.26 MAF
RETAINED FIXED COST = $52 M (2)
REVENUE – SALE OF GROUNDWATER RIGHTS = $8 M
PAYMENT $173/175 M
RECLAIMED WATER PRODUCER
TOTAL FLOW = 2.46 MAF
TOTAL PRODUCTION COST = $342/273 M (3)
MWD (TERMINATED SOURCE)
TOTAL FLOW = 2.26 MAF
RETAINED FIXED COST = $127 M
PAYMENT $169/98 M
PAYMENT $127 M
STATE WATER PROJECT CONTRACTORS (VIA DWR)
TOTAL FLOW = 2.46 MAF
TOTAL REVENUE REQUIRED = $296/225 M

NOTES:
1. Amount of reclaimed water used is 0.2 MAF less than the amount produced due to excess groundwater recharge.
2. Retained fixed cost is the amount of money required due to interruption of existing domestic water service.
3. Costs and revenues are 1975 Present Worth dollars for Alternative B-4/Alternative E-1 over the planning period (1980 – 2000).

figure 5.12

CASH FLOW CHART FOR RECLAIMED WATER FINANCIAL ANALYSIS — SYSTEM NO. 6

PLANNING PERIOD: 1980–2000


RECLAIMED WATER USER
TOTAL FLOW = 2.66 MAF(1)
TOTAL WATER COST = $269 M
RECLAIMED WATER PENALTY COST = $51/49 M(3)
REVENUE – SALE OF GROUNDWATER RIGHTS = $16 M
PAYMENT $234/236 M
LOCAL WATER PURVEYOR
TOTAL FLOW = 2.66 MAF
RETAINED FIXED COST = $52 M(2)
REVENUE – SALE OF GROUNDWATER RIGHTS = $8 M
PAYMENT $190/192 M
RECLAIMED WATER PRODUCER
TOTAL FLOW = 2.86 MAF
TOTAL PRODUCTION COST = $410/341 M(3)
MWD (TERMINATED SOURCE)
TOTAL FLOW = 2.66 MAF
RETAINED FIXED COST = $149 M
PAYMENT $220/149 M
PAYMENT $149 M
STATE WATER PROJECT CONTRACTORS (VIA DWR)
TOTAL FLOW = 2.86 MAF
TOTAL REVENUE REQUIRED = $369/298 M

NOTES:
1. Amount of reclaimed water used is 0.2 MAF less than the amount produced due to excess groundwater recharge.
2. Retained fixed cost is the amount of money required due to interruption of existing domestic water service.
3. Costs and revenues are 1975 Present Worth dollars for Alternative B-4/Alternative E-1 over the planning period (1980 – 2000).

REFERENCES

Ayers, R.W. and Branson, R.L., *Water Quality Guidelines for Interpretation of Water Quality for Agriculture,* University of California, Cooperative Extension, January 15, 1975.

Blevins, Melvin, *City of Los Angeles vs. City of San Fernando, et al – Landmark Decision in California Water Law Annals,* presented at Tenth Biennial Conference on Groundwater, September 12, 1975.

California Administrative Code, Title 22, Chapter 4, Sections 60303 – 60319, Wastewater Reclamation Criteria

California Department of Health, *Intent of Regulation: Groundwater Recharge by Surface Spreading* (Draft), 1976

California Department of Water Resources, *Watermaster Service for the West Coast Basin, 1975,* DWR Bulletin 179–75.

California Water Resources Control Board, *Policy and Action Plan for Water Reclamation in California,* January, 1977

California Water Resources Control Board, *Water Quality Control Plan for Ocean Water of California,* 1972.

County Sanitation Districts of Orange County and U.S. Environmental Protection Agency, *Technical Appendix on Water Use and Wastewater Reclamation,* Appendix K to *DEIS on CSDOC Wastewater Management Program,* March 1977.

Engineering-Science, Inc., *Proposed Pre-Treatment and Transmission Facility for the City of Glendale,* Environmental Impact Report No. 394, June, 1975.

Engineering-Science, Inc., Koebig and Koebig, Inc., *Feasibility Study for Glendale–Los Angeles Water Reclamation Plant,* March, 1969.

Flett, Douglas B., *Wastewater Reclamation for Industrial Use,* Jour. AWWA, Volume 67, February, 1975.

Goleta County Water District, *Environmental Assessment Supplemental Water Supplies Program,* September, 1975.

Lawrence, Charles H., *Existing Indirect Cost of Urban Water Use,* J. Envir. Engg. ASCE, Volume 100, August, 1975.

Los Angeles Department of Public Works, *City of Los Angeles Wastewater Facilities Plan,* Draft.

Los Angeles Department of Recreation and Parks, *Griffith Park Water System Phase I,* prepared by Keith and Associates, April, 1977.

Los Angeles Department of Recreation and Parks, *The Master Plan for Griffith Park,* prepared by the SWA Group, May, 1977.

Los Angeles Department of Water and Power, *Second Project Report on the Los Angeles Water Recycling Project, Playa del Rey,* May, 1976.

Los Angeles Department of Water and Power, *The Effect of Sepulveda and Los Angeles–Glendale Water Reclamation Plants on Domestic Water Quality,* December, 1975.

Los Angeles Department of Water and Power, Los Angeles Department of Public Works, and Los Angeles Department of Recreation and Parks, *Feasibility of Water Reclamation in Los Angeles,* 1968.

Los Angeles Department of Water and Power, *Salt Balance and Groundwater Trends in the San Fernando Valley,* April, 1977.

Los Angeles Department of Water and Power, *Survey of Industrial Water Users for Water Reclamation Potential,* 1967, 1973.

McKee, J.E. and Wolf, H.W., *Water Quality Criteria,* Publ. No. 3–A, California State Water Quality Control Board, pp. 97–8, 1963.

Petrasek, Albert Jr. and Steven Esmond, *Industrial Uses of Municipal Wastewater,* Industrial Water Engineering, July/August, 1973.

Roberts, Edwin B. and Robert M. Hagan, *Energy Requirements of Alternatives in Water Supply, Use and Conservation: A Preliminary Report,* California Water Resources Center, U.C. Davis, December, 1975.

Sanitation Districts of Los Angeles County, *Reconnaissance Study, Undeveloped Water Reuse Potential in the Joint Outfall System, 1975,* Appendix L to *Draft EIS/EIR on Joint Outfall System Facilities Plan,* April, 1976.

U.S. Environmental Protection Agency, *A Guide to the Selection of Cost-Effective Wastewater Treatment Systems,* EPA 430/9-75-002, July, 1975.

U.S. Public Health Service, *Drinking Water Standards,* 1962.

Addendum II

environmental analysis of the city of Los Angeles proposed wastewater reclamation activities

ADDENDUM II

ENVIRONMENTAL ANALYSIS OF THE CITY OF LOS ANGELES' PROPOSED WASTEWATER RECLAMATION PROGRAM

SEPTEMBER 1977

Prepared for:

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Los Angeles, California

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1. SUMMARY

There is a general recognition of the need for water reclamation in Southern California, and although many official policies support the concept of reclamation, its implementation is restricted because of the potential for adverse secondary impacts. Unresolved health issues are probably the most important potential secondary impacts currently constraining uses of reclaimed water. So long as reclaimed wastewater is considered unacceptable as a drinking water supply, separate distribution systems will be required, and additions of reclaimed water to aquifers and other storage facilities that are used for public water supplies will be restricted. These limitations place severe economic and regulatory constraints on the major potential uses of reclaimed water in the Los Angeles area (industrial use and groundwater recharge uses).

Some potential impacts of using reclaimed water have been identified by the State Water Resources Control Board (SWRCB) and are listed below as potential benefits and constraints.

The potential benefits include:

- Augmentation of local supplies and improvement of groundwater quality in many instances.
- Reduction of the need for construction of water development and conveyance projects and the associated adverse environmental impacts.
- Reduction of the need for further interbasin freshwater transfers in the state.
- Reduction of energy requirements in situations where reclamation is an alternative to importation of freshwater or disposal of wastewater.
- Reduction of pollution loads.
- Reduction of land subsidence and groundwater overdrafting when used for groundwater recharge.
- Availability of nutrients when used for irrigation water.
- Augmentation of stream flow, development of wetlands and lakes, restoration and enhancement of fish and wildlife habitat.
- Creation of scenic water bodies for recreation and aesthetic enjoyment.

The potential constraints to using reclaimed water include:

- The possible presence of pathogenic organisms, such as bacteria, virus, and toxic constituents, such as stable organic compounds, heavy metals, etc., which raises questions that need resolution for certain uses and requires that the quality of reclaimed water be carefully matched to other beneficial uses.
- Environmental impacts, such as groundwater degradation, downstream beneficial uses, accumulation of toxic materials in soil, plants, animals, etc.
- A requirement that the reliability of conventional waste treatment facilities be maintained at a high level.
- A requirement for the development of improved and more expensive monitoring techniques.
- The economic disadvantage when compared with the pricing structure of many other water supply sources.
- The lack of public and user acceptance prior to implementation of specific projects.

Addendum I describes the two Wastewater Facilities Plan Alternatives for the City of Los Angeles that could provide reclamation for up to 193 million gallons per day (mgd), or 45 percent of the projected total wastewater flow in the year 2000. Costs and feasibility of reclamation facilities are described and potential markets are assessed. This water reclamation environmental analysis, Addendum II, discusses the secondary impacts of the potential water reclamation provided by the two proposed wastewater management plan alternatives described in Addendum I. The primary impacts of plant construction and operation are described in Chapter VIII of the EIS.

1.1 Summary of Reclamation Alternatives

The two Facilities Plan Alternatives addressed in Addendum I are identified as "B" and "E." Both Alternatives "B" and "E" include the construction and operation of the Sepulveda Treatment Plant, but Alternative "E" includes the additional construction of the La Cienega Water Reclamation Plant (LCWRP). A major difference between these two alternatives is that better quality effluent is predicted with Alternative "E" and potential industrial customers are better served. Under "B", the Hyperion Treatment Plant (HTP) is designed for sewage disposal only. Pure oxygen is used for secondary treatment aeration and sludge from upstream treatment goes back into sewers to Hyperion. Under Alternative "E" the system is modified to benefit water reclamation by producing better quality effluent. The La Cienega plant is built upstream from HTP and produces 75 mgd of filtered secondary effluent using the standard rate process. Sludge from Sepulveda and La Cienega is segregated from the sewers

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and conveyed in a separate line to Hyperion. Also, Hyperion operates with fine bubble aeration for secondary treatment.

There are subalternatives under both "B" and "E" which are under serious consideration in the Facilities Plan. All "B" alternatives propose to provide hydraulic relief to the San Fernando Valley by construction and expansion of an inland treatment plant, the Sepulveda Facility, in the Sepulveda Flood Control Basin. Alternative B4, which proposes expansions at both Sepulveda and the existing Los Angeles-Glendale Water Reclamation Plant (LAGWRP), is further divided into subalternatives. The Facilities Plan selection process determined that subalternative B4C was the most viable of the "B" alternatives and for the purpose of the study[7] it was selected as representative of the "B" category. The discussion of Alternative B's impact on reclamation includes additional distribution facilities to augment the B4C alternative presented in the Facilities Plan.

Alternative "E" is divided into subalternatives E1 and E2. Both of these include construction of the La Cienega WRP at 75 mgd capacity upstream from HTP. The distinction between E1 and E2 is in the way HTP is modified. Alternative E1 calls for initial construction of 232 mgd of secondary capacity (high rate, fine bubble) to upgrade HTP with advanced primary to temporarily achieve standards in processing 307 mgd. Alternative E2 calls for initial construction of the full 307 mgd secondary capacity (high rate, oxygen) to upgrade HTP with later conversion to 232 mgd (high rate, fine bubble) when La Cienega is built. Alternative E1 is proposed as a possibility to satisfy secondary requirements for the interim period until La Cienega is operational and can provide secondary treatment. Such an approach would require at least a limited study, special regulatory consideration, and a change in the NPDES permit.

1.2 Summary of Proposed Uses for Reclaimed Water

Addendum I identifies potential markets by service areas (Table 1-1) and further analyzes the factors that are sensitive to the choice between Alternatives "B" and "E." These factors include monetary costs, energy requirements, land deficiencies, and revenue deficits to provide reclaimed water to the potential water markets which could be served from HTP. The use of reclaimed water from the Sepulveda and the LA-Glendale plants is not sensitive to these alternatives. The magnitude of this sensitivity to Alternatives "B" and "E" is dependent upon the level of reclaimed water use. The study[7] essentially concludes that implementation of Alternative "B" would result in increased requirements for dollars, energy, land, and revenue support as compared to "E" for reclamation facilities alone. If the costs for wastewater treatment are added, Alternative E is more costly with the exception of revenue requirements.

Although Addendum I identifies a maximum potential use of reclaimed water up to 193 mgd (216,000 acre feet/year) (Table 1-2), some of the potential markets are probably too small to be served economically so

Table 1-1. Reclaimed water service areas.

LOCATION	USE	FLOW (MGD)	YEAR IMPLEMENTED
Griffith Park	Irrigation	5	1980
Glendale Steam Plant	Industrial	3	1980
Sepulveda Basin Recreation Area	Irrigation	9	1980
Headworks/Tujunga Spreading Grounds	Groundwater Replenishment	45	1985
Standard Oil Refinery El Segundo	Industrial	8	1985
Southwest Los Angeles Industries	Industrial	52	1985
Vernon-Commerce Industries	Industrial	20	1985
West Coast Basin Barrier Project	Seawater Intrusion Barrier	35	1990
TOTAL		177	

they were eliminated. This reduced the maximum potential use to a somewhat more realistic total of 177 mgd (198,000 acre feet/year). Proposed uses of reclaimed water from the City of Los Angeles facilities include groundwater recharge by spreading in the San Fernando Valley, groundwater recharge by injection as a seawater intrusion barrier for the coastal area between LA International Airport and the Palos Verdes Peninsula, industrial use for cooling or other purposes, and irrigation of recreational and other landscaped areas. The quantities of water potentially required by these uses are shown in Table 1-1. These potential markets and uses are subject to many constraints and uncertainties and some may never be realized or at least greatly delayed as discussed in this report.

1.3 Summary of Potential Secondary Impacts of Proposed Wastewater Reclamation

The Environmental Protection Agency defines secondary impacts of a proposed project as indirect or induced changes.[8]

Table 1-2. Potential reclaimed water use.

USE[1]	QUANTITY	
	MGD	AF/YR
Groundwater Replenishment by Spreading	45	50,400
Seawater Intrusion Barrier Supply	35	39,200
Industrial Water Supply	85	95,200
Irrigation and Recreation[2]	28	31,400
Total Potential Use	193	216,200

[1] Potential reclaimed water use shown is based on successfully developing all identified uses that could be supplied from City of Los Angeles wastewater treatment plants.

[2] This use includes providing reclaimed water for fighting fires within the park. Such a use does not involve a significant volume of water on a daily average.

The Council on Environmental Quality comments that, "Such secondary effects, through their impacts on existing community facilities and activities, through inducing new facilities and activities, or through changes in natural conditions, may often be even more substantial then the primary effects of the original action itself."[9]

The Los Angeles Basin is a water-import region, so, according to the Metropolitan Water District (MWD),[3] local water reclamation and reuse would tend to reduce diversions from distant river basins or free those diversions for use in other areas. The impacts that would result from the changes in withdrawal or availability of water in regions other than the Los Angeles area are not addressed in this report. The Owens Valley (east of the Sierra Mountains, about 300 miles north of Los Angeles) is the major source of water used in the City of Los Angeles. An Environmental Impact Report has been prepared on a proposal to pump additional quantities of groundwater from the Valley. This and other projects to increase water importation to Los Angeles might be reconsidered should extensive reclamation prove feasible. Impact discussions covering the effects of increased withdrawals are required on each such project.

This report deals with secondary impacts which would occur in the Los Angeles area should water reclamation be implemented. Many of these potential secondary impacts are currently acting as, and are discussed as, constraints to implementation because potential adverse effects are not adequately understood or are unacceptable. Potential impacts are discussed according to the proposed reclaimed water uses from which they might result.

Major potential secondary impacts include adverse effects on public health if reclaimed water containing pathogenic bacteria or viruses mixed with drinking water supplies in aquifers or other storage facilities. Similar concerns apply to the presence in reclaimed water of trace amounts of chemical toxicants, such as heavy metals or organic compounds having poorly understood effects on human health as the result of chronic exposure. Potential contamination of aquifers is of particular concern because it would be a long-term effect, possibly precluding most future uses of the aquifer.

Reclaimed water stored in aquifers is subject to complex water rights laws and precedents. The water supplies of users, including the City of Los Angeles when wishing to withdraw groundwater, are potentially affected by legal constraints. Legal issues are reviewed from a historical perspective and applied to the recharge proposals.

Changes in land use as a result of the availability of reclaimed water are expected to be neither extensive nor immediate. Clustering of water intensive industries might occur in areas readily served by reclamation facilities if the price of reclaimed water were low compared to other sources. Since the extent to which reclaimed water costs might be subsidized as compared to other sources of water is unknown, an assessment of desirability to users based on economics is not possible.

Other secondary impacts examined in this report include potential effects of reclaimed water on other utilities, on reliability of supplies, on terrestrial and aquatic biology, and on recreational facilities.

2. THE REGULATORY ENVIRONMENT

Water reclamation in California has been practiced in various forms for many years but is becoming increasingly subject to regulatory constraints. Recent findings implicating low concentrations of contaminants in some public water supplies as cancer inducing agents when consumed for long periods of time have focused attention on health concerns. At the same time, water shortages in California and the high costs of recent water importation projects have underscored the need for acceptable and cost-effective uses of reclaimed water. While the reclamation and reuse of wastewater are generally endorsed as worthwhile water conservation tactics, there are, nevertheless, many constraints to their use and complex problems to be resolved in the future.

2.1 Background and Recent Developments Regarding Water Supplies

With a statewide water shortage expected to increase from 2.6 million acre feet in 1972 to 4.6 million acre feet annually by the year 2000,[1] the concept of wastewater reclamation and reuse has become increasingly attractive to citizens and governmental agencies in California. It has been widely endorsed as a water conservation tactic and is embodied as a policy statement in the state's water code: "It is the intention of the legislature that the state undertake all possible steps to encourage development of water reclamation facilities so that reclaimed water may be made available to help meet the growing water requirements of the state." (Calif. Water Code Section 13512; Operative January 1, 1970.)

The shortages of water experienced in California during 1977, the second year of the severest drought in the state's history, have emphasized the need everywhere to conserve water. In May 1977, the Los Angeles City Council for the first time in the City's history made water conservation mandatory. The Metropolitan Water District (MWD) urged its 27 member agencies, their subagencies and all city and county governments in Southern California to enact water-saving ordinances even more stringent than that of Los Angeles. On 15 May 1977, the MWD issued a special advertising circular entitled, "25 Things You Can Do To Save Water (and Survive Drought)." This prompted an editorial in the Sunday, 14 May 1977, edition of the Los Angeles Times endorsing the circular and urging people to "please read it and respond to it."[16]

> The ad itself sets a precedent. Never before in its 50 year history had the Met (MWD) bought space and time in the media to plead for water conservation. (The circular appears not only in the Times but also in today's editions of 21 other newspapers in the district's Southern California service area.) In addition, the water agency bought more than 3,100 radio commercials on 94 stations to urge its 11 million customers to cut back on water use. Altogether, the Met is spending more than $250,000 to *discourage* the sale of its product.[16]

The Times also pointed out that "the Met has given up its full entitlement from the California Aqueduct for the rest of this year because of even more critical conditions in the northern and central sections of the state."

> Because of adverse . . . decisions in the courts, the Los Angeles Department of Water and Power cannot pump the additional water supplies it requires from the Owens Valley. Our only other major source—the Colorado River Aqueduct—is now delivering a full capacity. The fact is that we cannot bring more water into Southern California than we are bringing now.[16]

The Los Angeles Times ended its editorial urging citizens to conserve water for the following reasons:

> Do it not because of ordinances that could impose harsh penalties for waste, including a possible cutoff of service for persistent violations of mandatory rationing.
>
> Do it because the well could run dry if you don't.[16]

While it is not true that the "well" will run dry for the City of Los Angeles as the Times dramatically states, it is true that any amount of reclaimed water would tend to reduce the City's purchases of water from the Metropolitan Water District, and to that extent alleviate the general problem in Southern California.

2.2 State Water Resources Control Board's Policy and Action Plan for Water Reclamation in California

Although Section 13512 of the California Water Code (*supra*) is a very clear policy statement to encourage water reclamation, the general emphasis during the first years of the 1970s was not on wastewater reclamation but was instead placed on pollution control and on achieving the federal standards of high water quality. So it was not until 18 January 1976 that any major effort was made to implement the legislative direction of Section 13512. On that date the State Water Resources Board (SWRCB) assembled a 55 member task force to assist SWRCB in the development of a "Policy and Action Plan for Water Reclamation in California."

According to SWRCB the factors compelling the initiation of this plan of action for the reclamation and reuse of wastewater were (1) impending water shortages in certain areas of California, (2) the higher levels of treatment now given to wastewaters, and (3) the constraints and unknowns involved with the use of reclaimed water to augment "freshwater" supplies.

The task force prepared the plan,[1] public hearings were held. Invited comments were submitted prior to November 1, 1976. Then in December 1976 it was reviewed by SWRCB which in January, 1977, adopted the following "Principles" and approved certain actions to implement them:

> I. The State Board and the Regional Boards shall encourage, and consider or recommend for funding, water reclamation projects which meet Condition 1, 2, or 3 below and which do not adversely impact vested water rights or unreasonably impair instream beneficial uses:
>
> (1) Beneficial use will be made of wastewaters that would otherwise be discharged to marine or brackish receiving waters.
>
> (2) Reclaimed water will replace the use of freshwater or better quality water.
>
> (3) Reclaimed water will be used to preserve, restore, or enhance instream beneficial uses, which include but are not limited to fish, wildlife, recreation, and aesthetics associated with any surface water or wetlands.
>
> II. The State Board and the Regional Boards shall (1) encourage reclamation and reuse of water in watershort areas of the State, (2) encourage water conservation measures which further extend the water resources of the State, and (3) encourage other agencies, in particular the Department of Water Resources, to assist in implementing this policy.

> III. The State Board and the Regional Boards recognize the need to protect the public health and the environment in the implementation of reclamation projects.
>
> IV. In implementing the foregoing Principles, the State Board or the Regional Boards, as the case may be, shall take appropriate actions, recommend legislation, and recommend actions by other agencies in the areas of (1) planning, (2) project funding, (3) water rights, (4) regulation and enforcement, (5) research and demonstration, and (6) public involvement and information.

On 1 January 1977 SWRCB issued a memorandum[2] setting forth specific directions for all Regional Boards and suggestions for designated 208 agencies to follow in planning for wastewater reclamation.

The directions to the Los Angeles and Santa Ana Regional Boards were as follows:

> The Los Angeles and Santa Ana Regional Boards should jointly coordinate a regional wastewater reclamation study for the Los Angeles-Orange County metropolitan area. The State Board will consider making a facilities planning grant (Step 1) to a joint power authority consisting of the major wastewater and water management agencies in the study area and the Department of Water Resources to conduct the study. The objective of this study is to bring together all major wastewater discharges and water purveyors in this water-short region and perform jointly the necessary facilities planning studies, including pilot studies and environmental impact assessment, for the long-term beneficial use of reclaimed water including fish and wildlife enhancement. The organization and management of this areawide program should be organized and structured similar to the ongoing LA/OMA Wastewater Solids Management Program, i.e., the State Board will have an active role in directing the program. This study should be completed by 1 July 1978. Implementation of the study findings should begin between July 1 and December 31, 1978.
>
> Regional Board 4 is further requested to cooperate with the Ventura Regional County Sanitation District to ensure that designated 208 planning covers the scope of reclamation planning studies listed above for nondesignated areas of the state. The Regional Board should also ensure that appropriate portions of the results of ongoing reclamation studies being conducted by U.S. Bureau of Reclamation are incorporated in the Phase II planning documents for this area.

2.3 Problems Between Water Purveyors and Wastewater Treatment Agencies

This new emphasis on water reclamation clearly necessitates cooperation between public and private water purveyors and the agencies which have the responsibility for wastewater treatment. The awkwardness of these treatment agencies being thrust into a position of also having substantial water supplies to sell to users is readily apparent. The necessary adjustments to this new situation may often be difficult and will certainly raise problems that have not previously been encountered.

For example, the Board of Directors of the Metropolitan Water District has endorsed efforts by its own staff and other agencies in research leading to the appropriate safe use and application of wastewater as a means of meeting a portion of the future water requirements of Southern California.[3]

From these activities the MWD recognized that:

> . . . the future use of reclaimed wastewater could be very important for Southern California in deferring, or possibly eliminating, the need for any future and highly expensive projects to import additional supplies of supplemental water from other areas. *However, we do not believe that reclamation projects should be built to make obsolete the investment in and use of the State Water Project, which has already been completed* [emphasis added].
>
> The capital and fixed operating costs of the State Water Project must be paid irrespective of the quantity of water being furnished, so that the variable operating cost is all that can be reduced if reclaimed wastewater can be put to use at a lower cost than the marginal cost of the State water it would replace.[3]

The MWD further recognized that:

> . . . if the total amount of State water that is imported is reduced, then the high costs involved must be recovered through the sale of a smaller volume of water, with the result that the cost of all water sold by Metropolitan would need to be increased and taxes maintained at higher levels than would otherwise be required.[3]

The magnitude of these problems cannot now be ascertained, but they do suggest the nature of future difficulties.

2.4 Funding of Wastewater Reclamation Plans and Facilities

In its "Principles" and its planning directive to Regional Boards there are references by SWRCB to the funding of water reclamation projects and facilities planning grants. The sources of such funds are in the Federal and State Clean Water Grant Programs authorized by the California Clean Water Bond Laws of 1970 and 1974 and in the Federal Water Pollution Control Act of 1972 (PL 92-500). These sources of funds are primarily for the purpose of constructing municipal wastewater treatment facilities to meet state and national water pollution control objectives. These laws were passed before the present emphasis on water reclamation arose, but SWRCB is interpreting them to permit funds for water reclamation.

> The federal law states that waste treatment management that results in revenue producing facilities providing for reclamation of wastewater shall be encouraged. The state law provides that in reviewing applications for grants, the SWRCB shall give added consideration to applicants with existing or proposed facilities which provide for optimum wastewater reclamation and subsequent use of reclaimed water. While the current Water Grant Program Regulations and guidance documents would allow funding of reclamation projects, *revisions are appropriate to provide increased emphasis on the development of projects for wastewater reclamation* [emphasis added].[1]

In its planning criteria SWRCB has included "Water Reclamation and Reuse. Water quality control plans shall be developed to provide for and encourage early implementation of water reclamation where water reclamation is *cost-effective*" (emphasis added; 23 Calif. Adm. Code, Sect. 2105).

In its statewide project list for treatment works SWRCB has established project groups with priority classes for funding within each group (23 Calif. Adm. Code, Sects. 2106, 2107, 2108).[3] Now SWRCB has adopted amendments to these Clean Water Grant Program Regulations to require increased consideration of reclamation alternatives in the development of water pollution control projects (Groups I, II, and III) and to create a Group IV for reclamation projects. While projects in Groups I, II, and III are needed to meet water pollution control requirements and many create additional water supply sources, projects in Group IV will be those projects that are not needed to meet water pollution control requirements but that would create additional water supply sources.[1,4]

Unfortunately, at present, distribution facilities are not generally grant fundable. These are, however, essential facilities to provide reclaimed water to potential user areas. SWRCB is proposing changes to increase funding available for some distribution facilities associated with the use of reclaimed water excluding all facilities utilized for dividing and applying the effluent to a particular use.

2.5 Conflict of Water Rights and Water Reclamation

The increased emphasis on the reclamation of wastewater has legal complications with existing water rights which SWRCB seeks to resolve through new legislation. While SWRCB presently administers the state's water rights program and issues permits and licenses for the appropriation of water and is charged with taking actions to prevent waste and unreasonable use of water, it has no approval function over water supply contracts. Therefore SWRCB is seeking legislation to permit its review of all water supply contracts except those for domestic purposes or those for less than 250 acre-feet per year. It is proposed that after an evaluation, the SWRCB may approve or disapprove such contracts, subject to conditions requiring the use of reclaimed water to the extent such use is determined by the SWRCB to be feasible and in the public interest.[1]

In addition SWRCB is seeking legislation to provide that, whenever cessation of or reduction in the use of water under an existing right occurs because of the substitution of reclaimed water, the right shall not be subject to loss or reduction, but shall be deferred. This legislation is needed because, under existing law, failure to exercise an existing water right may, under some circumstances, result in loss or reduction of the right. Thus, the risk of loss of an existing right may deter the right holder from using reclaimed water.

In addition to seeking the proposed legislative changes, SWRCB is planning amendments to its Water Rights Regulations to encourage and perhaps require the use of reclaimed water and the reuse of water as part of its ongoing water rights administration program. Increased consideration of the potential for such use and reuse shall be required of applicants for water rights and holders of existing rights. The SWRCB will consider requiring the use of reclaimed water or reuse of water on a case-by-case basis when it acts on water rights applications and petitions.

2.6 Role of Department of Water Resources

The state's Department of Water Resources also has an important role in the future use of reclaimed water. The DWR is revising the management element of the California Water Plan to recommend priorities for water management actions to allocate water supplies. Wastewater reclamation will be a major consideration in evaluating water management actions. According to the Water Management Policy of DWR, 7 May 1975, water shall be reused to the maximum extent feasible and in comparing alternative water management possibilities, the least expensive alternative will not necessarily be selected.

2.7 Role of the Environmental Protection Agency (EPA)

The EPA is not directly responsible for regulating uses of reclaimed water. However, EPA's activities influence whether or not reclamation facilities are constructed, and EPA is responsible for promulgating and enforcing public drinking water standards.

Federal grants for public wastewater treatment systems are administered through the EPA. The EPA must approve projects before federal and state funds amounting to a total of 87.5 percent of design and construction costs are committed. In addition, the EPA is responsible for publishing the Environmental Impact Statement required under the National Environmental Policy Act.

Furthermore, if proposed uses of reclaimed water from a federally funded project were anticipated to induce growth or other development potentially worsening air quality in a critical air basin, the EPA would require mitigation measures.

These activities of the EPA strongly influence the potential for water reclamation by determining the types of treatment facilities and the locations and capacities of these facilities. Currently, there are no grant funds available for reclaimed water distribution systems, so this responsibility is held entirely by the local municipalities and potential water users. In general, wastewater treatment systems necessary to produce an effluent desirable for industrial reuse are more costly to construct and operate than those needed to produce an effluent meeting discharge requirements for receiving waters. Therefore, it is advisable to be confident of markets for reclaimed water before committing to the more expensive system and possibly accepting some other disadvantages. On the other hand, it is undesirable for a major capital investment to preclude future opportunities for water reclamation should markets develop in the future. The EPA weighs these types of considerations while reviewing grant applications.

In December 1975[30] and July 1976[31] the EPA promulgated National Interim Primary Drinking Water regulations to become effective June 24, 1977. (Primary standards are those pertaining to potentially harmful constituents whereas secondary standards pertain to those constituents of aesthetic importance.) The interim primary standards have been reviewed by the National Academy of Sciences (EPA, July 1977)[33] and final primary standards will be published by the EPA on the basis of review comments, best available treatment technology, and other considerations. Proposed secondary standards, intended as guidelines to states, were published in March 1977[32]. The EPA is charged with enforcing the primary standards, but the direct responsibilities will generally be turned over to states following approval of proposed programs and adoption of the federal standards or more strict standards.

The protection of public water supplies extends to groundwater used for a drinking water source. The Safe Drinking Water Act (PL 93-523) requires the EPA to publish regulations for underground injection control programs to assure that groundwaters reasonably expected to supply any public water system will not be contaminated. The EPA is currently drafting an "Underground Injection Control Program." Whether or not recommended measures will apply to spreading for groundwater recharge is, as yet, undetermined.

2.8 Role of Department of Health

The role of the Department of Health is crucial in determining the manner in which reclaimed wastewater is used. Under the California Water Code "the State Department of Public Health shall establish statewide reclamation criteria for each varying type of use of reclaimed water where such use involves the protection of public health." (Water Code, Section 13521.)

Reclamation criteria are defined as "the levels of constituents of reclaimed water, and means for assurance of reliability under the design concept which will result in reclaimed water safe from the standpoint of public health, for the uses to be made." (Water Code, Section 13520.)

The Department has established criteria for the following uses of reclaimed wastewater:[5]

1. The irrigation of food crops.
2. The irrigation of fodder, fiber and seed crops.
3. The irrigation of pasture for milking animals.
4. Landscape irrigation.
5. Recreational impoundments.

In the case of irrigation of food crops the criteria vary with the method of application. For example, spray irrigation requires that the water "shall be at all times an adequately disinfected, oxidized, coagulated, clarified, filtered wastewater," while surface irrigation only requires that the water "shall be at all times an adequately disinfected oxidized wastewater." Even less restrictive is the regulation that, "Orchards and vineyards may be surface irrigated with reclaimed wastewater that has the quality at least equivalent to that of primary effluent provided that no fruit is harvested that has come in contact with the irrigating water or the ground."

In spray irrigation the wastewater is considered adequately disinfected if at some location in the treatment process the median number of coliform organisms does not exceed 2.2 per 100 milliliters and the number of coliform organisms does not exceed 23 per 100 milliliters in more than one sample within any 30-day period. The median value is determined from the bacteriological results of the last 7 days for which analyses have been completed.

In "oxidized" wastewater the organic matter has been stabilized, and the water is nonputrescible and contains dissolved oxygen.

"Coagulated wastewater" means oxidized wastewater in which colloidal and finely divided suspended matter have been restabilized and agglomerated by the addition of floc-forming chemicals or by an equally effective method. Coagulation is accomplished by injecting aluminum salts, iron salts such as ferric chloride, or lime into the wastewater. The resulting floc is removed by gravity sedimentation.

Filtration is achieved by passing wastewater through a granular bed typically 30 in. to 60 in. deep composed of relatively small particles (less than 1.5 mm in size). In advanced wastewater treatment (AWT) processes the reduction of contaminants in effluent include chemical coagulation and sedimentation, filtration, carbon adsorption, biological and physical chemical nitrogen removal processes, disinfection, demineralization, chemical oxidation with ozone, and storage in effluent reservoirs.

Activated carbon adsorption is the most practical method available for removal of refractory organics. Wastewater is passed through beds of granular carbon made up of carbon particles about 0.8 mm in effective size. The spent carbon may be thermally regenerated and reused. Nitrogen may be removed by biological nitrification and denitrification; or by the physical-chemical processes of selective ion exchange, ammonia stripping, or breakdown chlorination. Salt buildup in water reuse systems can be controlled when necessary by use of processes such as ion exchange, reverse osmosis, or electrodialysis. The AWT processes provide substantial reductions in bacteria and viruses but complete disinfection is dependent upon use of a disinfection process such as chlorination or ozonation. Storage of wastewater in open reservoirs can perform useful treatment functions by allowing natural purification processes to supplement the AWT processes.[6]

Pending completion of studies to establish scientifically supported criteria for the use of reclaimed wastewater for groundwater recharge by spreading, the State Department of Health in May 1976 proposed a set of interim regulations for the operation of recharge projects. These have subsequently been modified, and are expected to be issued in final form in the near future.

These modified interim regulations require, as a minimum treatment, an adequately oxidized wastewater which has received treatment by the unit processes of carbon adsorption and percolation through an unsaturated zone of undisturbed soil for a minimum vertical distance of 10 feet. This minimum treatment chain must be supplemented by various operational controls. The regulations are designed to assure that the quality of the reclaimed water after treatment and soil percolation meets the chemical and physical standards for drinking water in California. Effective performance of the treatment process and indication of efficient organic removal is substantiated by meeting the limits of 5 mg/l specified for chemical oxygen demand (COD) and 3 mg/l for total organic carbon (TOC).

The interim criteria also require that not more than 50 percent of the water entering a groundwater basin at the spreading area during any 12-month period shall be reclaimed water. In the absence of this, the Department of Health requires strong evidence that dilution with natural groundwater would at all times occur. The regulations require the establishment of a contingency plan which will specify corrective measures, including extraction of degraded water, to be taken in the event that groundwaters are determined not to be safe as a result of the recharge operation.

The proposed Health Department regulations do permit adjustments on a case-by-case basis particularly in the implementation of a health monitoring program and the meeting of radioactivity standards. Chlorination for disinfection is excluded as a result of concern over the formation of potentially toxic chlorinated hydrocarbons in the water if chlorination is practiced. The Health Department believes that safe water can be achieved without chemical disinfection by (1) percolation through the soil and (2) at least a year in transit to the nearest well.

Efficient operation of groundwater recharge projects requires a quality of reclaimed water which will maintain high infiltration rates for periods of time. Low concentrations of suspended solids and organic matter minimize the rate of soil clogging which can determine the success of a groundwater recharge operation.[6]

One criterion, with which the City of Los Angeles may have difficulty in compliance, is the 50 percent blending with imported water at the point of spreading. Therefore, the City must show evidence of at least 50 percent dilution underground with native waters at the well site.

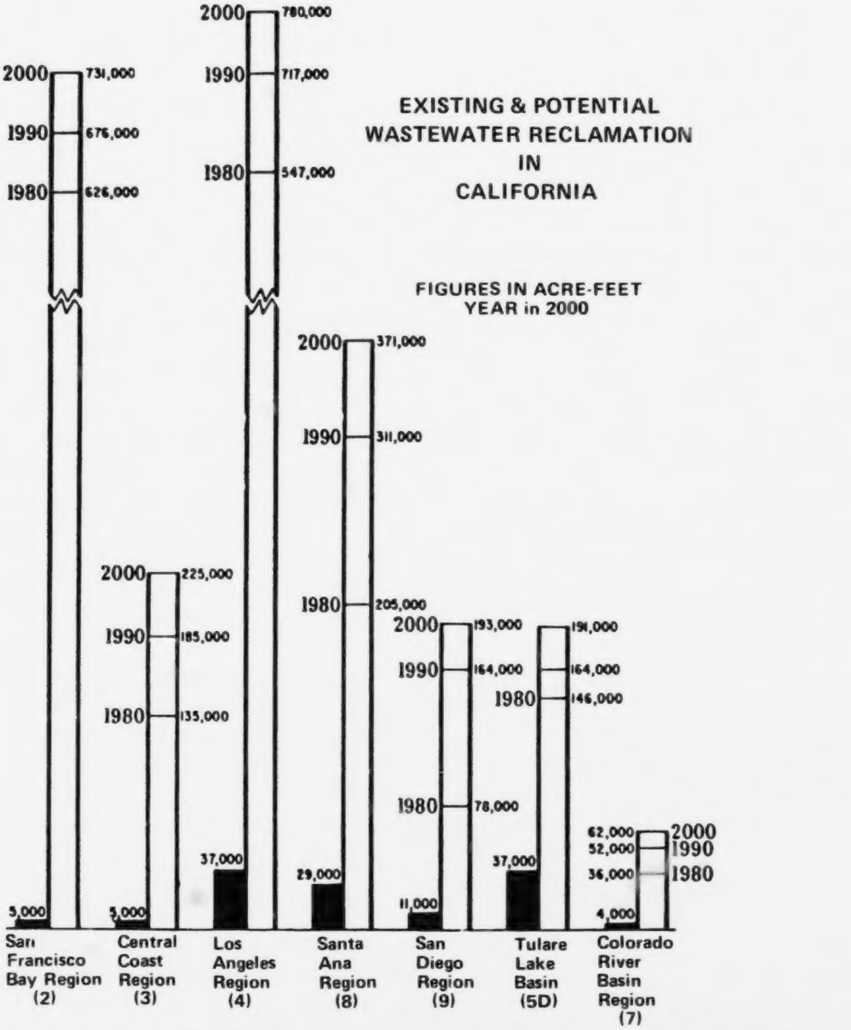
3. POTENTIAL FOR WATER RECLAMATION IN CALIFORNIA AND SOME EXAMPLES

Although statewide agriculture now uses reclaimed water to grow more than 20 different crops, and some agricultural uses date back to as early as 1945, the use of reclaimed water has never played more than a small part in California's total water supply picture.[22]

> Californians now require some 31 million acre-feet of freshwater a year for all purposes: municipal, industrial, and agricultural. About 2.8 million acre-feet of this—approximately 91 million gallons—are obtained by overdrafting groundwaters or by purchasing water from other areas that eventually may need the water now being exported. By the year 2000, this annual excess demand is expected to increase to 4.6 million acre-feet. The North Coast rivers, protected by wild and scenic river designation, remain the only untapped freshwater sources of any magnitude in the state.
>
> In 1975, Californians produced about 3.1 million acre-feet of treated municipal and industrial wastewater. This is likely to increase to 4.7 million acre-feet by the year 2000. Although not all of this will be reclaimable, because of high total dissolved solids or some other constituents, about 3.2 million acre-feet could be reclaimed, and, of that amount, approximately 80 percent is a potential new source of water supply. (These figures represent an estimate of reclamation potential and do not consider detailed economic and technical constraints.) [Figure 3-1][22]

A survey by the State Water Resources Control Board shows that California needs to build $5 billion worth of sewage treatment facilities just to meet the needs of its projected population in 1990. Against this background, the State Board determined that good water management policy dictates that reclaimed water be used as much as possible. As part of its "Reclamation Policy and Action Plan," the State Board is recommending $4.2 million in research and demonstration projects to be conducted over a 5-year period to learn more about the health effects and environmental impacts associated with long-term use of reclaimed water. In addition, the Board is recommending to the Legislature that additional research funds be made available as part of the next Clean Water Bond issue that the Legislature is expected to submit to the people in 1978.[22]

> Today, there are about 194 water reuse and reclamation projects throughout California using treated water for agriculture, landscape irrigation, artificial lakes, industrial



The black areas show the amount of water currently being reclaimed and reused in the areas of the state where the greatest potential for reclamation exists. The open bars show the amounts of water that will be available to reclaim and reuse between now and the year 2000. If not reclaimed and reused, much of this water, which still must receive secondary treatment to comply with federal standards, will be wasted to the ocean or other saline body of water.

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Figure 3-1. Existing and potential wastewater reclamation in California (J. Auer, 1977).

> and power plant cooling, and groundwater recharge. Approximately 34 more projects are in the planning or construction stage, using federal and state monies provided through the Clean Water Grant Fund, and other projects are being built with private funds. For the most part, all of these projects are small, producing from 0.01 to 15 million gallons daily (mgd) of reclaimed water.[22]

In California, the most common use of reclaimed water has been for irrigation of crops, and the results of a number of studies on this practice have been published. Most of this research has considered the effects of salinity or trace elements on plant growth and the tolerance of certain crops to such wastewater constituents. Relatively little investigative work has been done on the economics of wastewater reuse or in the comparative costs of energy involved.

At the request of the State Water Resources Control Board, a University of California "Committee of Consultants" published *Guidelines for Interpretation of Water Quality for Agriculture*"[23,25] (Table 3-1). These guidelines are flexible and intended for use in estimating the potential hazards to crop production associated with the long-term use of the particular water being evaluated. These guidelines are subject to modification by local experience and special conditions of crop, soil, method of irrigation, or level of soil-water-crop management. These guidelines include data on the use of saline waters for livestock and poultry and data on levels of toxic substances in drinking water for livestock. Since the publication of these guidelines, specific experiments with wastewater have been conducted.

Among impurities added to municipal wastewaters, trace elements have attracted the attention to many researchers in recent years. The term "trace element" includes a number of chemical elements that occurs in natural systems in small concentrations. They are utilized by organisms in minute quantities, and most are essential to growth. When present in high enough concentrations, trace elements may become toxic.

Boron, cadmium, chromium, copper, lead, mercury, nickel, and zinc, widely used in industrial processing and in manufacturing of consumer goods, are the most common trace elements in municipal wastewater (Table 3-2). Consistently high concentrations usually indicate waste discharge into the collection system by certain industries. The actual concentrations of trace elements in wastewater, therefore, vary considerably with the nature of the communities.[24]

Quality criteria, applicable to various water uses and recommended by a National Academy of Science and National Academy of Engineering Joint Committee in 1972, are shown in Table 3-3. Most waste effluents could meet these recommended trace element requirements for crop irrigation. Among elements likely to exceed the upper limits, lead and cadmium are closely related to industrial wastes. Another, boron, is found commonly in household cleaning products.[24]

Table 3-1. Guidelines for interpretation of water quality for irrigation.*

IRRIGATION PROBLEM	DEGREE OF PROBLEM		
	NO PROBLEM	INCREASING PROBLEM	SEVERE PROBLEM
Salinity (affects water availability to crop)			
ECw (mmhos/cm)	< 0.75	0.75-3.0	> 3.00
Permeability (affects infiltration rate of water into soil)			
ECw (mmhos/cm)	> 0.5	0.5-0.2	< 0.2
adj. SAR	< 6	6-9	> 9
Specific Ion Toxicity (affects only sensitive crops)			
Sodium (adj. SAR)	< 3	3-9	> 9
Chloride (meq/l)	< 4	4-10	> 10
Boron (mg/l)	< 0.5	0.5	2.0-10.0
Miscellaneous Effects (affects only suceptible crops)			
NO_3-N (or) NH_4-N (mg/l)	< 5	5-30	> 30
HCO_3 (meq/l) [overhead sprinkling]	< 1.5	1.5-8.5	> 8.5
pH		[Normal range 6.5-8.4]	

ECw—electrical conductivity a measure of water salinity
Adj SAR—adjusted Sodium Adsorption Ratio
NO_3-N—nitrogen in the water in form of nitrate
NH_4-N—nitrogen in the water in form of ammonia
pH—measure of acidity (0-7)or of alkalinity (7-14) pH = 7 is neutral

*From Ayers & Branson (1977)[25]

Table 3-2. Sources of trace elements in wastewater.*

ELEMENT	SOURCES
As	Glass, ceramics, textiles, paints, pesticides
Ba	Fabrics (printing and dyeing), paper manufacturing, rubber
Be	Plating, organic chemical catalyst
Bi	Electrical fuse, solders, dental works, pharmaceutics
B	Detergents, cleansing agents, glue
Cd	Plating, battery cell, pesticides, contaminants in Zn
Cr	Plating, tanning
Cu	Plating, pickling, synthetic fabric, utensils
Pb	Battery, paints, gasolines
Hg	Paints, medical uses
Mo	Ceramic glaze, lubricants
Ni	Plating, dyes, inks, electrodes
Se	Photography, rubber, insecticides
Ag	Photography, plating
V	Medical use, metal alloy
Zn	Plating, galvanizing, rubber, synthetic fabrics

*From Chang and Page, 1977.[24]

Table 3-3. Concentration of trace elements in wastewater versus water quality criteria.*

ELEMENT	WASTEWATER EFFLUENT		WATER QUALITY CRITERIA		
				IRRIGATION WATER	
	RANGE	MEDIAN	PUBLIC WATER SUPPLY	CONTINUOUS USE**	SHORT-TERM USE***
	mg/l	mg/l	mg/l	mg/l	mg/l
As	<0.005-0.023	<0.005	0.1	0.1	2.0
B	0.3 -2.5	0.7	-	0.75	2.0
Cd	<0.005-0.22	<0.005	0.01	0.01	0.05
Cn	<0.001-0.1	0.001	0.05	0.1	1.0
Cu	0.006-0.053	0.018	1.0	0.2	5.0
Hg	<0.0002-0.001	0.0002	0.002	-	-
Mo	0.001-0.018	0.007	-	0.01	0.15
Ni	0.003-0.60	0.004	-	0.20	2.0
Pb	0.003-0.35	0.008	0.05	5.0	10.0
Se	-	-	-	0.02	0.02
Zn	0.004-0.35	0.04	0.05	2.0	10.0

*From Chang and Page, 1977.[24]

**For water used continuously on all soils.

***For use up to 20 years on fine-texture soils of pH 6.0 to 8.5.

Considering the extreme variability of trace-element uptake and toxicity tolerance among plant species, as well as possible interactions with minerals and organics in soils, maximum acceptable trace-element concentrations in irrigation water may vary. However, the median concentrations shown in Table 3 [Table 3-3] are clearly below the standards for continuous use. As indicated in the table, somewhat higher levels are suitable for short-term use (20 years) on certain soils. (Fine-textured soils remove a significant amount of trace elements from the soil solution, so more trace elements can be in the irrigation water without injury to crops grown on these soils.) In the case of effluents that do not meet recommended maximum concentrations, boron and cadmium are the most likely problem elements.[24]

One study of the effect of saline waters on crops was motivated by a projected 50 percent increase in salinity of Colorado River water by the turn of the century, and the data have been used in making a decision for the use of wastewater for irrigation in a city disposal project at Calipatria. Yields of 12 crops irrigated with water containing 877 mg/l and 1,350 mg/l dissolved solids (representing present and projected Colorado River water concentrations) were measured over a 3-year period. Snap beans, onions, and carrots showed the greatest yield reductions from the higher salinity; lettuce, broccoli, and sorghum showed no yield reduction (Table 3-4).[26]

Table 3-4. Reductions in yields of crops from a change in irrigation salinity from 877 mg/l to 1,350 mg/l, 1973 to 1976 (Robinson, et al., 1977).[26]

CROP	PREDICTED YIELD REDUCTION	MEASURED YIELD REDUCTION
	PERCENT	PERCENT
Snap bean	25.8	34.1
Onion		
Granex 33	12.3	11.8 - 16.0
Early Premium	12.3	6.8 - 8.4
Carrot	19.2	12.9 - 14.7
Cauliflower		12.1
Sugar beet	0	0 - 9.0
Cantaloupe	6.2	9.2
Cabbage	9.4	6.4
Wheat	0	2.7 - 6.8
Alfalfa	8.1	1.7 - 7.6
Broccoli	0.8	0
Lettuce	15.0	0
Sorghum	0	0

An irrigation trial was conducted for Morro Bay to compare the use of Morro Bay City water with the effluent which it now discharges into the ocean. It was concluded after applying water equivalent to at least 4 years of irrigation on two types of soil—a fine sandy loam and a clay—that the use of the effluent water would not result in excessive sodium accumulation and serious water penetration problems.[27]

During the past two years, treated wastewater has been used successfully to irrigate forage crops on 1,100 acres in Sonoma County. The City of Santa Rosa, with the help of federal and state funding, is delivering effluent to local farmers from a treatment plant with a dry-weather flow of approximately 5.5 mgd. Farmers cannot use the water during winter months so the North Coast Regional Water Quality Control Board permits the City to discharge secondary-treated effluent during this period into Santa Rosa Creek as long as certain dilution factors are maintained.[28]

Various cities and sanitation districts within Sonoma County are working on plans to irrigate an additional 4,000 acres with treated wastewater. These agencies are considering crop irrigation with wastewater for a specific purpose—to meet their discharge requirements with costs equal to or lower than other methods. The following comments were made by Brandon J. Riha, Director of Public Works for Santa Rosa, in discussing plans for a large new regional treatment facility serving the cities of Santa Rosa, Sebastopol, Rohnert Park and Cotati:

> The decision to go to land irrigation . . . means the City can avoid the addition of costly treatment facilities. The operation and maintenance costs for wastewater reclamation have proven to be significantly less than full tertiary treatment. On the basis of a 20-year life, the city would pay approximately $430,000 annually in operation and maintenance costs for land irrigation as compared with approximately $935,000 for tertiary treatment.

Approximately 80 percent of the potential for wastewater reclamation in California is in basins where wastewater is being discharged to brackish or saline water—mainly the Pacific Ocean. Unfortunately, the potential reuse of such water for irrigation of crops is mostly inland. This poses two questions: Would reuse of wastewater on farmland require less energy than discharge to the ocean? If so, would it require more or less energy than importation of fresh water for irrigation?[29]

In the greater Los Angeles area, water imported from the Colorado River requires about 2,075 kilowatt-hours per acre-foot (kWh/AF) for pumping. Water imported through the fully developed State Water Project after year 2020 will require 2,767 to 3,292 kWh/AF, depending on delivery elevations.[29]

Municipal wastewater discharged to the Pacific Ocean requires considerable energy for secondary treatment and pumping through a long ocean outfall. Since wastewater reused for irrigation of fodder, fiber, and seed crops requires only primary treatment, each acre-foot reused could save about 200 kWh in direct energy requirements compared to ocean disposal by eliminating the secondary treatment and ocean outfall pumping. Under current health regulations, wastewater reused for pasture irrigation and surface irrigation of food crops requires secondary treatment. Therefore, reuse instead of ocean disposal would save only the approximately 50 kWh otherwise required for outfall pumping. Wastewater reused for sprinkler irrigation of food crops requires secondary treatment plus chemical coagulation and filtration. Such reuse would require slightly more direct energy—possibly 10 kWh—than ocean disposal of the wastewater.[29]

Adequate cropland for large-scale irrigation reuse of wastewater from the Los Angeles area is many miles inland and at a higher elevation. Also municipal use typically raises the salt concentration of water by about 350 ppm, and the greater salt concentration may reduce certain crop yields. To be fully comparable with freshwater, wastewater must be of equal quality and be delivered to the same elevation.[29]

4. POTENTIAL SECONDARY IMPACTS OF USING RECLAIMED WATER FOR GROUNDWATER RECHARGE

According to the proposal to use reclaimed water for groundwater recharge, the water would infiltrate into aquifers through permeable soils of spreading grounds, would mix with groundwater of other origins, would be stored in the aquifers for indeterminate periods of time, and would eventually be withdrawn and distributed in the public water supply system. The impacts (if any) on public health of implementing this proposal are largely unknown. Potential impacts and some of the areas requiring additional study are detailed in this section.

Other potential impacts affect legal jurisdictions over water, groundwater quality changes expected at various withdrawal points, and various secondary issues. These problems are addressed in this section.

4.1 Health Aspects of Wastewater Reclamation for Groundwater Recharge

From the standpoint of human health, there are several water quality factors of particular significance in groundwater recharge by reclaimed water. These are:

1. Microbiological contaminants
2. Inorganic chemical contaminants
3. Organic chemical contaminants
    (a) Organo-metallic compounds
    (b) Stable (refractory) organic compounds

In addition to contaminant levels, there are significant unresolved questions over monitoring.

4.1.1 MICROBIOLOGICAL CONTAMINANTS. The infectious agents of most importance are those whose origin is the intestinal discharge of man or other animals. These can be broadly classified as bacterial, parasitical, and viral.

4.1.1.1 Bacteria. Many species of bacteria in the genus *Salmonella* are pathogenic and may be transmitted from man to man by contaminated water. They cause three forms of salmonellosis in man: enteric fevers, septicemias, and acute gastroenteritis.

Typhoid fever caused by *Salmonella typhosa* is the most severe enteric fever form of salmonellosis, and man is the only host. Fortunately, modern sanitation and water treatment practices have so reduced the morbidity that epidemiologists are beginning to speak in terms of eradication, but a 1973 outbreak of 213 cases in Dade County, Florida, indicates that continued vigilance is required. Salmonella septicemias are relatively rare, but the third form of salmonellosis, acute gastroenteritis, is commonly encountered. The usual source of these organisms is food, particularly poultry products, and the incidence of waterborne salmonellosis is low. However, in an outbreak in Riverside, California, in 1965, in which 18,000 people were infected, there was evidence that the water supply was implicated.

Until recently (one isolated case in Texas), cholera has not been present in the United States and the bacterial agents of tuberculosis and leptospirosis, although important, do not, from an epidemiological point of view, appear to be significant in municipal wastewater.

Although zero concentration of these pathogenic bacteria in water is not a realistic concept, it would appear that significant numbers of bacteria, particularly the *Salmonella,* are required to produce disease in man as shown by the available dose-response data for humans. Therefore, some tolerance is allowable in the numbers of these organisms that may be present in water to be recharged. Although specific examination of waters for pathogenic bacteria is seldom done, the use of indicator organisms (fecal coliform bacteria) as indirect measurement of pathogenic bacteria has been practical for half a century. This experience has provided considerable information on bacterial contaminants in waters, their sources, movements and survival in groundwater,and has provided a reliable sampling method that is included in the state's reclamation criteria.

4.1.1.2 Parasites. There are myriad diseases of protozoan and metazoan etiology which are transmitted from man to the environment to man in fecal material and many may be associated with water. In the U.S., the most serious parasitical disease to be associated with wastewater is amoebic dysentery caused by *Entamoeba histolytica*. Generally, the use of indicator bacteria is considered adequate to determine the quality of water with regard to parasites as well as bacterial pathogens. Size and other characteristics make their presence in groundwaters extremely unlikely.

4.1.1.3 Virus. Overt instances of recognized waterborne viral disease transmission have been relatively uncommon. However, in recent years, improved laboratory technology for recovery of viruses from water has resulted in reports describing widespread occurrence of viruses in treated sewage and surface waters.

> Once virus enters the water environment there is a number of potential modes of transmission to man, primarily through ingestion or bodily contact. This includes such activities as bathing, water contact sports, contact with crop or landscape irrigation waters, drinking from untreated or improperly treated water sources, and ingestion of shell fish.[6]

Because small amounts of ingested virus may produce an infection but not disease, it is likely that small amounts of viruses could be present in water and go undetected. In the case of infectious hepatitis, no host other than man has been found, making it extremely difficult to study the efficacy of treatment processes in removing or destroying the virus. Consequently, the viruses studied are usually poliovirus, coxsackie virus, and bacteriophages.[6]

> The tolerance for numbers of viruses present is most probably lower than for bacteria. Adequate dose-response data for viruses and human enteric disease do not exist. The consensus is that one tissue culture infectious dose—50 percent (TCID$_{50}$)—is enough to initiate infection in man, if not disease. Standards such as one viral plague-forming unit (pfu) per 100 gallons have been suggested as the quality standard for finished drinking water.
>
> Since all viruses that may be present cannot be isolated using a common detection method, it is urgent that some representative indicator virus be selected as the target organism to use in measuring virus removal efficiency. Such an indicator should be commonly present in sewage throughout the year and should be as resistant to treatment processes as is the agent for infectious hepatitis.[6]

There is little information on the health significance of low levels of virus in water, and very limited information on the fate of virus in treatment processes and the environment.

4.1.2 CHEMICAL CONTAMINANTS (INORGANIC). Unlike the ill-defined organic constituents present in reclaimed water which pose serious health concerns, the inorganic constituents of health significance are, for the most part, well known. The Drinking Water Standards (Table 4-1) include limits for heavy metals and other inorganic substances. The quantities of inorganic constituents in sewage effluents depend mainly on the type of waste (domestic or industrial) and the degree of treatment that the wastewater receives. The maximum levels allowable in drinking water are set forth in Tables 4-1 and 4-2.

The following review of the inorganic constituents of water indicates the state of knowledge of these chemicals.

Table 4-1. National Interim Primary Drinking Water Standards [40 CFR 141.11 (a) (1975)].[1]

INORGANIC CHEMICALS[2]	LEVEL (MG/L)
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium	0.05
Cyanide	0.2
Lead	0.05
Mercury	0.002
Nitrate (as N)	10.0
Selenium	0.01
Silver	0.05

[1] Based on assumed consumption of 2 liters/day.

[2] With the exception of nitrate, all inorganic chemical contaminant levels are based upon potential adverse health effects resulting from long-term exposure. The level for nitrate is applicable to all public water systems. The remaining levels apply only to community water systems.

Table 4-2. National Interim Primary Drinking Water Standards for fluoride [40 CFR 141.11 (b) (1975)].

When the annual average of the maximum daily air temperature for the location in which the community water system is situated is the following, the corresponding concentration of fluoride shall not be exceeded:

TEMP. F°	TEMP. C°	LEVEL MG/L
53.7 and below	12.0 and below	2.4
53.8 to 58.3	12.1 to 14.6	2.2
58.4 to 63.8	14.7 to 17.6	2.0
63.9 to 70.6	17.7 to 21.4	1.8
70.7 to 79.2	21.5 to 26.2	1.6
79.3 to 90.5	26.3 to 32.5	1.4

4.1.2.1 Arsenic. The major sources of arsenic are from pesticide manufacturing and formulating plants although arsenic occurs ubiquitously in nature. The arsenic concentration in most drinking water in the U.S. is less than 0.1 mg/l. No adverse health effects have been reported from the ingestion of water containing arsenic concentrations of less than 0.1 mg/l. Although arsenic has been suspected of being carcinogenic, evidence from human experience and animal studies indicates that arsenic is not tumorigenic at the levels normally encountered in the environment.[6]

4.1.2.2 Barium. For the public water supplies of the 100 largest cities in the U.S., the median barium concentration was 0.05 mg/l with a range of 0.01 to 0.058 mg/l. Since food does not contain any substantial quantities of barium, it enters the body primarily through air and water. The amounts of barium that can be tolerated in water have not been determined,[6] but the standard for drinking water is 1.0 mg/l.

4.1.2.3 Cadmium. Cadmium is a contaminant of zinc ore and, consequently, sources of cadmium pollutant in water are discharges from zinc smelting and refining and from processes using zinc ore for making galvanized steel. It is also used in agricultural chemicals and fertilizers. The possibility of seepage of cadmium into groundwater from electroplating plants has been reported.

Because of the cumulative retention of cadmium by liver and kidney tissue, the Drinking Water Standards limit concentration of cadmium to 10 ug/l so that the maximum daily intake of cadmium from water will not exceed 20 ug, which is about one-third of the amount of cadmium derived from food.

4.1.2.4 Chromium. Natural waters do not usually contain appreciable quantities of chromium. It enters the water environment from plating wastes, blown down from cooling towers and from circulating water in refrigeration equipment where it is used to control erosion. The form toxic to man is the hexavalent chromium ion. Trivalent chromium salts do not appear to be toxic, however, the trivalent form is not likely to be present in waters of pH 5 or above, due to the low solubility of hydrated oxide. It is not known whether chromium is carcinogenic. Studies have indicated that a chromium concentration of 0.05 mg/l with an average intake of 2 liters of water per day would avoid hazard to human health.[6] (See Table 4-1.)

4.1.2.5 Cyanide. Cyanide compounds are common in industrial wastes for they may derive from gas works, coke ovens, scrubbing of gases in steel plants, metal plating operations and chemical industries. The toxicity varies widely with temperature, dissolved oxygen concentration and especially with pH. The most toxic form is hydrogen cyanide (HCN) and it is the predominant form of "free cyanide" at pH levels of natural waters. Cyanide in doses of 10 mg or less is easily converted into thiocyanate in the human body and in this form is much less toxic to man. Lethal toxicity effects occur only when the detoxifying mechanism is overwhelmed. The cyanide level in water can be reduced to below the recommended limit of 0.2 mg/l by chlorinating to produce a free chlorine residual. The acute oral toxicity of cyanogen chloride, which is the chlorination product of hydrogen cyanide, is approximately one-twentieth that of HCN.[6]

4.1.2.6 Copper. Copper is an essential and beneficial element in human metabolism, and a deficiency results in nutritional anemia in infants, but copper imparts an undesirable taste to drinking water. Copper concentrations in surface and groundwaters are usually less than 1 mg/l. The limit of 1 mg/l for drinking water set in 1962 by the U.S. Public Health Service, Table 4-3, was based on considerations of taste rather than hazards to health.[6] Small amounts of copper are generally regarded as nontoxic. Copper can be removed from water by ion exchange and by proper control of pH, where the source of copper is the corrosion of copper pipes.

Copper does not appear on the National Interim Primary Drinking Water Standards (1975) (Table 4-1) but does appear on the proposed National Secondary Drinking Water Regulations (1977). (See Table 4-4.)

While primary regulations are devoted to constituents and regulations affecting the health of consumers, secondary regulations are those that deal with the aesthetic qualities of drinking water. These secondary regulations are not federally enforceable and are intended as guidelines for the states. While the contaminant levels in Table 4-4 may not have a significant direct impact on the health of consumers, their presence in excessive quantities may discourage the utilization of a drinking water

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Table 4-3. Maximum contaminant levels for organic chemicals [National Interim Primary Drinking Water Standards (40 CFR 141.12)].

Because these levels are based upon potential adverse health effects resulting from long-term exposure, they are applicable only to community water systems. The following are the maximum contaminant levels for organic chemicals.

CHLORINATED HYDROCARBONS	LEVEL (MG/L)
Chlordane	0.003
Endrin	0.0002
Heptachlor	0.0001
Heptachlor Epoxide	0.0001
Lindane	0.004
Methoxychlor	0.1
Toxaphene	0.005
CHLOROPHENOXYS	**LEVEL (MG/L)**
2.4-D	0.1
2, 4, 5-TP Silvex	0.01

Table 4-4. National Secondary Drinking Water Regulations Secondary Maximum Contaminant Levels for Public Water Systems [40 CFR 143.3 (1977)].

CONTAMINANT	LEVEL
Chloride	250 mg/l
Color	15 Color Units
Copper	1 mg/l
Corrosivity	Non-corrosive
Foaming Agents	0.5 mg/l
Hydrogen Sulfide	0.05 mg/l
Iron	0.3 mg/l
Manganese	0.05 mg/l
Odor	3 Threshold Odor Number
pH	6.5-8.5
Sulfate	250 mg/l
TDS	500 mg/l
Zinc	5 mg/l

supply by the public. In the use of reclaimed water for groundwater recharge, consumer acceptance could be a factor of some importance so these secondary regulations do require attention.

4.1.2.7 Fluoride. Fluoride has potential beneficial effects but in excessive amounts of drinking water produces objectionable dental fluorosis that increases as a continuum with increasing fluoride concentrations above the recommended control limits. The mottling of teeth, widely observed in the middle and southwest of North America, is the only harmful effect resulting from fluoride in drinking water in the U.S. The fluoride concentrations excessive for a given community depend on climatic conditions because the amount of water (and consequently the amount of flouride) ingested by children is primarily influenced by air temperature.[6] This is reflected in the current Drinking Water Standards, Table 4-2.

4.1.2.8 Hardness. The primary relationship between water hardness and human disease appears to be an increased incidence of cardiovascular disease among people living in areas serviced with soft water. Studies in England and Wales indicate a similar relationship between neonatal mortality and water hardness. No adequate reasons for these relationships are known.

4.1.2.9 Lead. Some of the principal sources of lead in the environment are agriculture, paint, smelters, metal salvage operations, and leaded gasoline. Lead is well known for its toxicity in both acute and chronic exposures. Because the general population is exposed to dangerously high levels of lead through food and air, lead in water must be limited to low concentrations. The normal intake from food is approximately 0.3 mg/day. Lead intoxication is unlikely to occur at a long-time intake level of 0.6 mg/day. Therefore, the maximum level of 0.05 mg/l for public water sources would only add 0.1 mg/day, assuming a two liter daily consumption of water.[6]

4.1.2.10 Mercury. The dissipative uses of mercury (infeasible to recycle) include paints, agricultural seed dressing, catalysts, dental fillings, pharmaceuticals and fungicides. A substantial amount of potentially recyclable mercury (batteries, switches, thermometers, fluorescent tubes, etc.) end up in landfills, dumps, and incinerators, thus making its way to the environment.

The mercury content of surface waters in the U.S. rarely exceeds 5.0 μg/l and is usually less than 1.0 μg/l. However, rivers draining basins having mercury deposits may contain as much as 80 μg/l. In general, the mercury in these waters is associated with suspended particles and the mercury concentrations decrease markedly downstream from the deposits. Mercury tends to adsorb readily on a variety of materials so stream sediments are likely to contain substantially higher mercury concentrations than the water itself. The mercury content of groundwater is normally less than 0.1 μg/l. Chronic poisoning from inorganic mercury compounds has most often been associated with industrial exposure, whereas that from organic mercury compounds has been the result of accidents or environmental contamination.[6]

4.1.2.11 Nitrate-Nitrite. Nitrates may find their way into groundwaters from such sources as agricultural drainage, domestic sewage, and leaching from naturally occurring nitrogenous formations. Shallow wells on farms and in rural communities in regions of intense fertilization and farm crop production often have high nitrate concentrations. The nitrate levels in many public water supplies in the U.S. are routinely higher than 10 mg/l, however, only one reported case of methemoglobinemia has been associated with a public water supply.

Methemoglobinemia is largely confined to infants less than three months old, and is dependent upon the bacterial conversion of the relatively innocuous nitrate ion (NO_3^-) to nitrite (NO_2^-). When ingested, the nitrates may be reduced to nitrite in the digestive tract of the infants. When absorbed from the digestive tract, the nitrites react with hemoglobin to form methemoglobin, a form of hemoglobin which is incapable of efficiently transporting oxygen to the tissues.

According to a report of the National Academy of Sciences entitled "Drinking Water and Health,"[33] the hazard that nitrate in water may act as a procarcinogen is more speculative. A series of reactions is involved by which it is proposed that nitrate in water may be converted to N-nitroso compounds that may be carcinogenic. The steps in the reaction sequence are:

1. Reduction of nitrate to nitrite.
2. Reaction of nitrite with secondary amines or amides in food or water to form N-nitroso compounds.
3. Carcinogenic reaction of N-nitroso compounds.

Epidemiologically, correlations have been shown between incidence of gastric cancer and concentration of nitrate in drinking water, but these findings are preliminary and only suggestive. While they provide no firm evidence of a causal link between incidence of cancer and high intake of nitrate, they do indicate a need for caution in assessing lack of adverse health effects even at 10 mg/l nitrate as nitrogen and a need for continued intensive study on the metabolism and effects of nitrate in man.

4.1.2.12 Radiologic. Of the naturally occurring radionuclides likely to be in water systems, radium-226 is of primary concern, although other terrestrial alpha particle emitters and radium-228 may also be present. Radium is usually not present in surface waters in significant amounts but occurs in groundwater as a result of geological conditions.

Man-made radioactivity may enter water systems. Past deposition of fallout material from nuclear weapons tests, particularly strontium-90 and tritium, is probably the most important source of contamination. The national use of radionuclides in medicine and industry and the utilization of nuclear power to supply energy needs may also lead to some radioactivity entering the aquatic environment.

Estimates of the possible health effects from maximum contaminant levels of radioactivity in drinking water have been based on the assumption that there is no harmless dose from ionizing radiation and that the detrimental effects on health produced will be proportional to the dose equivalent delivered to a person drinking 2 liters of water per day.

The proposed maximum contaminant level for radium in drinking water is 5 pico Curies per liter (5 pC/l). The potential risk due to this level is estimated to be between 0.7 and 3 fatal cancers annually per million exposed persons.

It is estimated that the total dose from man-made radioactivity in water supply systems is not likely to result in a total body or organ dose to any individual that exceeds 4 millirem per year and EPA has proposed this number as a maximum contaminant level of beta particle and photon radioactivity from man-made radionuclides. The potential risk of fatal cancer from a dose equivalent of 4 millirem per year is about 0.4 to 2 cases per million exposed persons per year with risks from lower dose rates proportionately smaller. Additional health risks of genetic effects and nonfatal cancers are each estimated to be comparable to that for cancer fatality. Partial body irradiation is common for ingested radionuclides since they may, like radium, be largely concentrated in a particular organ system. In such cases, the risk per rem varies depending upon the radio-sensitivity of the organs at risk. For example, the estimated number of thyroid cancers due to the thyroid gland receiving 4 millirem per year continuously range from 0.2 to 0.5 per year per million exposed persons (averaged over all age groups since the fatality rate of thyroid cancers varies with age).[6]

4.1.2.13 Selenium. Elemental selenium is highly insoluble and requires oxidation to selenite or selenate before appreciable quantities appear in water. The reaction may be catalyzed by certain soil bacteria. There has been only one case of selenium toxicity from a water source, and it resulted from a three-month exposure to well water that had a selenium concentration of 9 mg/l.[6]

4.1.2.14 Silver. Less than 10 percent of 1,577 samples collected at 130 sampling points in the United States had detectable concentrations (0.1 μg/l) of silver. It requires a quantity of silver greater than 1 g to cause argyria in an adult (argyria is a permanent gray discoloration of skin, eyes, and mucous membranes).[6]

4.1.2.15 Sodium. Sodium salts are highly soluble and ubiquitous in the water environment. Groundwaters are often higher in sodium content than surface waters. The sodium content of the 100 largest water supplies in the U.S. had a median sodium content of 12 mg/l. Most of these were surface water supplies. For a healthy individual the sodium intake may average 6.0 g/day without adverse health effects. Sodium has long been linked with hypertension and physicians recommend restricted sodium intakes for persons suffering from hypertension, edema associated with congestive cardiac failure, and women with toxemias of pregnancy. Diets for these individuals permit sodium concentrations of 20 mg/l in drinking water and water used for cooking. In some instances, distilled, deionized, or low sodium surface waters may have to be substituted for drinking waters with a high sodium content in the dietary therapeutic regimen for these patients.

4.1.2.16 Metal Carcinogens. The field of metal carcinogenesis is complicated, and although such metals as arsenic, beryllium, cadmium, chromium, nickel, and selenium have been suggested as possibly being carcinogenic under certain circumstances, information on this is generally inadequate. The available information indicates that pure metallic nickel and many of its compounds and metallic cadmium can be considered as sources of cancer. The exact role of metals as carcinogens has not been determined. The 1975 review of the health aspects of wastewater reclamation for groundwater recharge states that "there is a great need for information on the carcinogenicity of metals that may develop only after long-term exposure."[6]

4.1.3 ORGANIC CHEMICAL CONTAMINANTS

4.1.3.1 Organo-Metallic Compounds. Most trace metals in water exist not as the free metal ion, but instead are found in the form of hydroxo or other soluble complexes, or in association with colloidal organic or inorganic impurities suspended in the water.

Tannic acid and other products of vegetative decay have been shown to complex ferrous iron and interfere with Fe (II) oxidation and its subsequent removal from groundwater. So organo-metallic complexes are found in waters containing appreciable concentrations of organic material.

The classic example of organo-metallic complex formation is the alkylation of metals, particularly the methylation of heavy metals. A specific example of this process is the methylation of mercury. It is predictable that tin, palladiym, platinum, gold, and thallium will be methylated in the environment, but that lead, cadmium and zinc will not. This is because the latter alkylmetals are not stable in an aqueous medium. Arsenic compounds also are reduced and methylated by anaerobic bacteria to give dimethylarsine and trimethylarsine as volatile products of extreme toxicity.

Alkylated metals are of concern because of their strong potential as neurotoxins. Most metal alkyls are more soluble in organic solvents than in water and so they readily partition into the lipid regions of a cell. The nonpolarity of metal alkyls probably represents the basic property which allows these molecules to accumulate in the central nervous system of higher animals. Once the metal alkyl is present, solubility allows it to concentrate in areas where it can do the most damage. "The movement of all inorganic contaminants in groundwater and percolating water is not well understood and is a suitable area for study."[6]

4.1.3.2 Stable (Refractory) Organic Compounds. In the past, conventional wastewater treatment processes have had as their objective the removal of 85-90 percent of the biodegradable organics found in raw municipal wastewaters. This was primarily to prevent depletion of oxygen in receiving waters. There was little, if any, concern over the removal of nonbiodegradable (refractory) organics. However, it was recognized that these refractory organics were potential sources of color and taste and odor problems in downstream water supplies. Of more concern, however, are the potential long-term health effects of the refractory organic materials found in reclaimed wastewater which is totally acceptable from an aesthetic view (i.e., colorless and odorless). A recent (1974) study concluded that there was a relationship between cancer mortality among white males and drinking water obtained from the Mississippi River at New Orleans. The suggested cause was the formation of carcinogens by the chlorination of refractory organics found in the raw water supply. An EPA study in 1974 found 65 identifiable organics in the treated New Orleans water supply. Refractory, stable, or residual organics are not removed readily by natural means or by reclamation processes. "Where groundwater recharge with municipal wastewaters is practical, special attention must be paid to the fate of the refractory organics found in secondary effluents."[6] It is possible with carbon adsorption in an advanced wastewater treatment (AWT) system to produce a COD (Chemical Oxygen Demand) lower than that used in the past for recharge in California and lower than that of many raw water supplies in the U.S. However, as the New Orleans reports indicate, the concentrations of organics in some existing supplies may be high enough to cause adverse health effects and there is uncertainty about what level of organics is acceptable. Most wastewater treatment studies do not report specific organic constituents but rather report results in terms of COD, TOC (Total Organic Carbon), CCE (Carbon Chloroform

Extract) or CAE (Carbon Alcohol Extract). These gross measurements of organic concentrations have well-known limitations. For example, the COD procedure fails to detect many straight-chain aliphatic and aromatic hydrocarbons, such as pyridine and benzene. "There is a definite need to think less in terms of BOD, COD and TOC and more in terms of specific trace compounds."[6] Table 4-3 identifies maximum limits for certain pesticides and herbicides.

> The uncertainty over the composition of the organics remaining after carbon treatment in turn introduces the major source of controversy related to reuse of municipal wastewaters. It is not universally agreed that trace organics need limit direct reuse in arid regions where such reuse is now a necessity due to lack of other water sources.[6]

Thus, the summary of the state of knowledge about stable, refractory organics:

> It is known that some organic materials are found in the most highly treated sewage effluents in milligram per liter quantities. These stable organics are of significance because of a combination of factors:
>
> 1. The composition of specific organic substances is not known.
> 2. The effect of treatment processes and passage through the soil on stable organic substances is unclear.
> 3. There is great uncertainty about the potential that these organics have to cause so-called chronic effects in man if ingested over a period of many years.[6]

It should be restated that information is lacking on the chronic health effects of specific organic compounds in water. At the present time, there seems to be no reasonable way by which one can estimate chronic toxicity from acute toxicity data. Yet, one of the major problems in making judgments about the public health impact of reusing treated wastewater is predicting the long-term effect of exposure to low doses of potentially carcinogenic or mutagenic compounds in drinking water.

Information is also lacking on the health significance of different levels of gross parameters (i.e., COD, TOX, CCE, CAE); on the effects of groundwater travel on organics and their persistence in the water environment.

4.1.4 MONITORING OF CONTAMINANTS. The proposed use of reclaimed wastewater for groundwater recharge will require a well-planned and carefully conducted monitoring program to ensure the maintenance of water quality standards. At a minimum, this would necessarily include monitoring of: (1) the reclaimed wastewater supply; (2) the water in wells nearest the areas of recharge; (3) the general basin groundwater; and (4) the blend of water in the River Supply Conduit. Failure to maintain requisite water quality standards could conceivably result in closure of certain wells or even an entire basin if serious health hazards arose.

A 1973 "Report on Program of Water Quality Monitoring" prepared for the Central and West Basin Water Replenishment District stated that:

> The frequency of sampling depends upon the use to be made of the data, the significance of a particular constituent in a given water and the rate at which changes in any characteristic in a particular water might be expected to take place over time. The frequency of analysis will be determined in the course of establishing the specific quality monitoring program.

That 1973 report was prepared before EPA in 1975 issued the National Interim Primary Drinking Water Regulations (40 CFR 141) which are very specific on monitoring and analytical requirements (40 CFR 141.21). These regulations reflect the fact that methods of analysis have become more sophisticated and certain new health concerns, particularly those over stable organics, have been expressed. These changes have occurred rapidly, and more are expected as better information accumulates. These new findings create uncertainties about the use of reclaimed wastewater for groundwater recharge, and they may have substantial effects on future operational procedures and costs.

The current standards (see Tables 4-1 and 4-2), are based on certain assumptions which have been challenged. For example, the maximum contaminant levels (MCLs) are based, directly or indirectly, on an assumed consumption of 2 liters of water per day. This assumption has been challenged because of numerous instances where much higher consumption rates occur. It has been argued that maximum contaminant levels (MCL) should be established to protect groups in the population who have an abnormal water consumption.

EPA's justification for using the 2-liter figure is that it represents somewhat above-the-average water or water-based fluid intake of all adults, and that, while the factor of safety may be somewhat reduced when above-average quantities of water are ingested, the maximum contaminant levels based on the 2-liter figure are adequate to protect all consumers. If, as has been suggested, a water consumption rate of 8 liters per day is used as the basis for maximum contaminant levels, all of the proposed MCLs would have to be divided by 4, greatly increasing the monitoring difficulties, and in some cases challenging the sensitivity of accepted analytical procedures. It could be expected, in such a case, that the MCLs would be exceeded to a significant degree, and that specialized treatment techniques would be required to order that the contaminant levels would be reduced. The economic impact of a move in this direction would be enormous. EPA believes that the use of the

2-liter figure is reasonable, and that it is not technically or economically feasible, nor necessary to base MCLs on the water consumption rates of abnormal individuals.[34]

The question has been raised as to whether ranges of MCLs should be established on the basis of the climate in the area served by the public water system as was done with fluorides. Because there is a small margin with fluoride between beneficial levels and levels that cause adverse health effects it is desirable to "fine tune" the fluoride-temperature relationship rather than establish a single level which may make the optimum fluoride level illegal in some parts of the country. Perhaps as more is learned about the health effects of inorganic and organic chemicals, it will be possible to use ranges for other contaminants based on temperature.[34]

The removal of sodium and sulfates from drinking water is in most cases not practical. Consideration has been given to monitoring these constituents, but they are not now included in the Primary Drinking Water Standards, although sulfates have recently (1977) been included in the proposed Secondary Drinking Water Regulations. (See Table 4-4.)

Since a number of persons suffer from diseases which are influenced by the dietary sodium intake and since there are others who wish to restrict their sodium intake, it is desirable that the sodium content of drinking water be known. Those affected can, by knowing the sodium concentration in their drinking water, make adjustments to their diets or, in extreme cases, seek alternative sources of water to be used for drinking and food preparation. It is possible that the state may institute a program for regular monitoring of the sodium content of drinking water served to the public, and for informing doctors and consumers of the sodium concentration in drinking water. A relatively high concentration of sulfate in drinking water has little or no known effect on regular users of the water, but transients using such water sometimes experience a laxative effect. It has been recommended that the states institute monitoring programs for sulfates, and that transients be notified if the sulfate content of the water is high. Such notification should include an assessment of the possible physiological effects of the water.[34]

It is almost a certainty that the future will see new regulations for organic contaminants. For example, the Carbon Chloroform Extract (CCE) standard was originally developed as a test for undesirable tastes and odors in drinking water. As concern developed over the health effects of organic chemicals, the possibility of using CCE as a health standard rather than as an aesthetic standard was considered. However, CCE has many failings as an indicator of health effects of organic chemicals. This is because the CCE test obtains information on only a small percentage of the total amount of organic chemicals in the water sampled. Furthermore, there is serious question as to the reliability of CCE in identifying those organic chemicals which are most suspected of adverse health effects. In addition, there are no existing data on which a specific level for CCE can be established on a rational basis.

> To establish a MCL under these circumstances would almost certainly do more harm than good. It could give a false sense of security to persons served by systems which are within the established level, and a false sense of alarm to persons served by systems which exceed that level. It would also divert resources from efforts to find more effective ways of dealing with the organic chemical problem (Env. Rept. "Current Developments," *id.*).

Therefore, research is underway to develop a surrogate analysis for gross organic contamination in drinking water. As soon as sufficient information is developed from the research, the drinking water standards will be amended. All these possible or predictable changes may alter the costs and operations of proposed uses for reclaimed wastewater.

4.2 Legal Issues Related to Groundwater Recharge of Reclaimed Water

Surface water rights in California have a complex legal history. In most cases, present rights are based partially on past withdrawals of water, original ownership of properties, and other historical factors. Groundwater rights are further complicated by uncertainties over the origin of waters, and other problems related to storage as well as withdrawal rights.

4.2.1 HISTORY OF RECHARGE PRACTICES IN THE UPPER LOS ANGELES RIVER AREA AND THE SAN FERNANDO BASIN. Surface spreading of water for groundwater recharge has been practiced by the City of Los Angeles for many years, but the water used has not been reclaimed wastewater as is now proposed.

In 1907, the City of Los Angeles commenced work on its Los Angeles Aqueduct (LAA) to import large quantities of water from the Owens River in Inyo County. The first Owens River water reached the San Fernando Valley on 5 Novermber 1913 and was all delivered into the City's mains, south of the Santa Monica Mountains. In May 1915, The City of Los Angeles annexed almost all of the San Fernando Valley thus increasing the City's territory from 115 to 285 square miles. In the same month, the City commenced delivery of Owens River water to the annexed territory primarily for irrigation purposes.

These events had two effects on the quantity of water available from the Los Angeles River and its underground supply in the Upper Los Angeles River Area (hereafter referred to as ULARA). These effects were that (1) the introduction of Owens water into the City's distribution system reduced the quantity of groundwater that the City was required to draw from the ULARA and (2) much of the Owens River water used for irrigation in the San Fernando Valley was returned underground and was mingled with and increased the ULARA's ground supply. The extent of this augmentation was substantial, for about 27 percent of the Owens water delivered to customers in the San Fernando Valley was returned to the underground reservoir.[10] This figure is further supported by the State Water Resources Control Board, as referee, in the Case of *City of Los Angeles v. City of San Fernando* (1975) 14 Cal. 3d 199 [537 P. 2d 1250]. The referee's studies of three water years showed that the following percentages of water delivered to users in the ULARA entered the underground supply:

WATER YEAR	PERCENTAGE
1949-1950	25.9
1954-1955	27.0
1957-1958	26.5

The ULARA has been defined[11] as the entire watershed of the Los Angeles River and its tributaries above Gauging Station No. F57, which is located just above the junction of the river and the Arroyo Seco, near the intersection of North Figueroa Street and San Fernando Road and the intersection of the Pasadena and Golden State Freeways. The ULARA is bounded by the crests of mountain ranges: The Santa Susana Mountains and San Gabriel Mountains on the north; the San Gabriel Mountains, San Rafael Hills, and Repetto Hills on the east; the Elysian Hills and Santa Monica Mountains on the south; and the Simi Hills on the west.[11] (See Figure 4-1.)

The "valley fill" portion of the ULARA is divided into four subareas. By far the largest of these subareas, comprising 112,047 out of the 123,428 acres in the total valley fill, is the San Fernando subarea, which includes most of the San Fernando Valley plus the Los Angeles River Narrows, located at the southeast corner of the ULARA. The natural course of the Los Angeles River is from west to east along the southern edge of the San Fernando Valley until it reaches what is now the northeast corner of Griffith Park and turns abruptly south, paralleling the Golden State Freeway through the Narrows down to Gauging Station No. F57.[11] (See Figure 4-1.)

The other three subareas of the valley fill are designated as Sylmar, Verdugo, and Eagle Rock. Sylmar is the area north of the City of San Fernando. Most of Sylmar is within the City of Los Angeles, but it also includes a small slice of San Fernando. The Verdugo subarea is the southerly half of the narrow valley east of the Verdugo Mountains, extending along Foothill Boulevard from the middle of the Tujunga district southeast through La Crescenta and Montrose. The Eagle Rock subarea is the Eagle Rock district of Los Angeles.

The City of Los Angeles delivers water imported through its aqueduct (LAA) from Owens Valley and Mono Basin to all parts of its territory within the ULARA, and for most of this territory, such imported water is the exclusive supply. The rest of this territory contains three service areas which receive some of their water from additional sources as follows: (1) The Mission Wells service area, located south and west of the City of San Fernando, receives groundwater from the Mission Wells in the Sylmar subarea. (2) The Sunland-Tujunga service area, overlapping the San Fernando and Verdugo subareas northeast of the Verdugo Mountains, receives

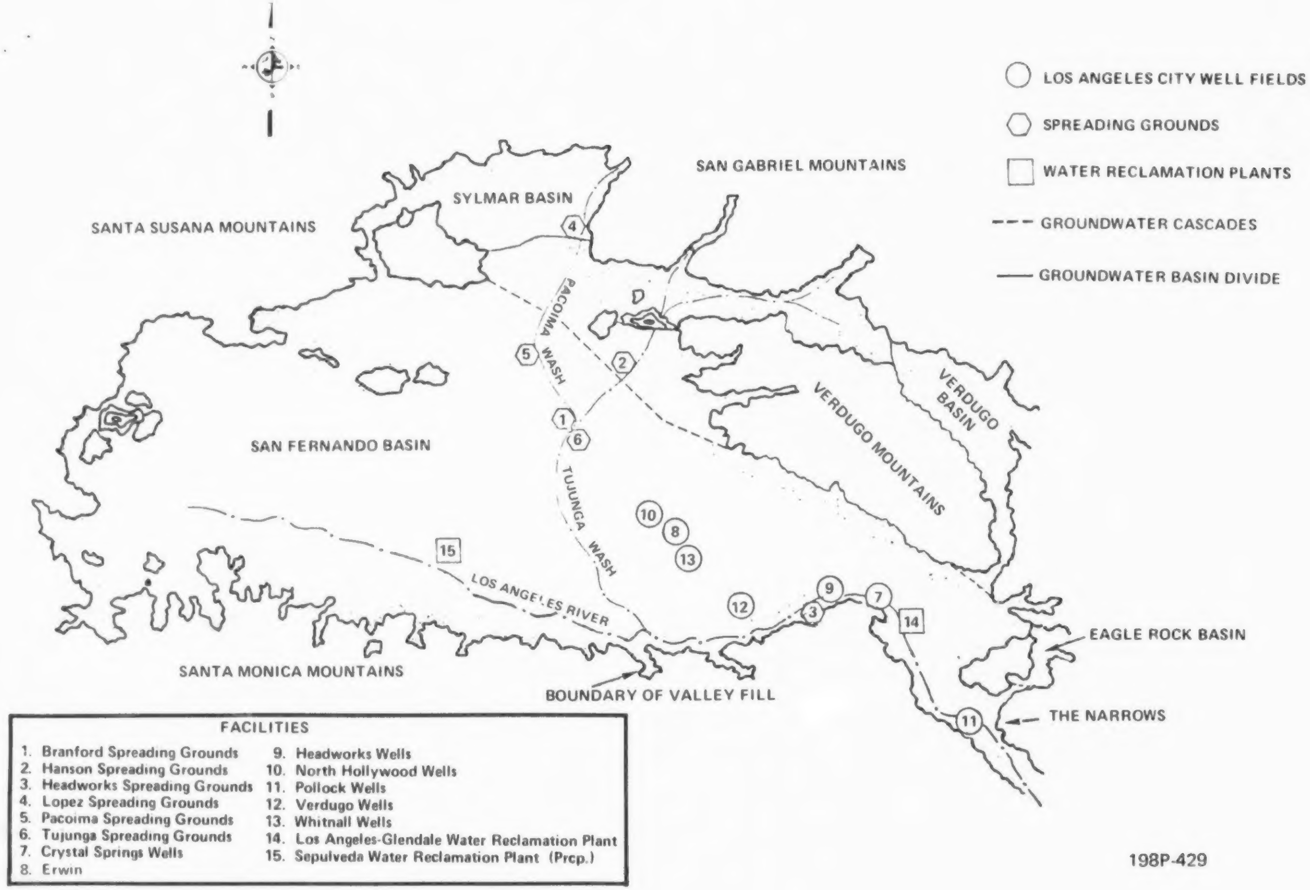

LOS ANGELES CITY WELL FIELDS
SPREADING GROUNDS
WATER RECLAMATION PLANTS
GROUNDWATER CASCADES
GROUNDWATER BASIN DIVIDE
SAN GABRIEL MOUNTAINS
SYLMAR BASIN
SANTA SUSANA MOUNTAINS
PACOIMA WASH
VERDUGO BASIN
VERDUGO MOUNTAINS
SAN FERNANDO BASIN
TUJUNGA WASH
LOS ANGELES RIVER
SANTA MONICA MOUNTAINS
BOUNDARY OF VALLEY FILL
EAGLE ROCK BASIN
THE NARROWS
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
FACILITIES
1. Branford Spreading Grounds
2. Hanson Spreading Grounds
3. Headworks Spreading Grounds
4. Lopez Spreading Grounds
5. Pacoima Spreading Grounds
6. Tujunga Spreading Grounds
7. Crystal Springs Wells
8. Erwin
9. Headworks Wells
10. North Hollywood Wells
11. Pollock Wells
12. Verdugo Wells
13. Whitnall Wells
14. Los Angeles-Glendale Water Reclamation Plant
15. Sepulveda Water Reclamation Plant (Prcp.)
198P-429

Figure 4-1. Western Los Angeles River area location map.

groundwater from nearby wells in the San Fernando subarea. (This occurs very seldom because of the poor quality groundwater.) (3) The Narrows service area, including the Los Angeles River Narrows and parts of Eagle Rock and Highland Park districts, receives imported water which emanates not only from the Owens Aqueduct (LAA), but also from the Metropolitan Water District (MWD). The MWD water comes from the Colorado River and from Northern California through the State Water Project.[11]

The groundwater which the City of Los Angeles extracts from the ULARA and does not deliver to the foregoing three service areas is exported from the ULARA. The exported water is taken from wells in the southeastern San Fernando Valley and in the narrows and flows by gravity to other parts of the City having a lower elevation.

4.2.2 WATER RIGHTS PRECEDENTS. Disputes over rights to the native waters of the Los Angeles River and to groundwaters of the San Fernando Valley supplying the river can be traced back to the early part of the 19th Century. In recent years as the area became more urbanized and demands for water increased these rights have been more frequently contested and have culminated in the landmark case of *City of Los Angeles v. City of San Fernando* (1975).[11]

The City of Los Angeles filed the above action in September 1955 to (1) quiet its title and obtain a declaration of its prior rights to the water underlying ULARA, and also (2) to enjoin the defendants from extracting such water other than in subordination of the City of Los Angeles' prior rights.

The defendants included the Cities of San Fernando, Glendale, and Burbank, the Crescenta Valley County Water District, and several private parties. These defendants obtained their water as follows: San Fernando formerly drew its entire water supply from City wells in the Sylmar subarea, but following extensive damage to its water supply system in the earthquake of February 1971, San Fernando joined the MWD and now supplements its groundwater supply with MWD water. Glendale extracts water from its wells in both the Verdugo and the San Fernando subareas and also purchases water from MWD. Burbank extracts groundwater from the San Fernando subarea and purchases MWD water. The Crescenta Valley County Water District extracts groundwater from the Verdugo subarea and purchases MWD water. All of the private defendants extract groundwater from the San Fernando subarea except two which extract from the Sylmar subarea.

All parties conceded that at least as of 1955, when this action was commenced, there was an annual overdraft in the San Fernando subarea and in the ULARA as a whole. Los Angeles asserted a need for, and a capacity to distribute to its inhabitants, the entire "safe yield" of the ULARA. Los Angeles also claimed that the defendants' taking of its groundwater caused it irreparable injury because imported water is more costly than groundwater. In fact, Los Angeles further asserted that the case was not about water but about money, i.e., who should pay for the more expensive imported water.[11] Groundwater is cheaper than Owens water and Owens water is less expensive than MWD water.

In considering the major elements of groundwater law there are four basic types of groundwater rights: (1) overlying, (2) appropriative, (3) prescriptive, and (4) pueblo.

Under the doctrine of overlying rights each landowner may extract all the groundwater he needs on his overlying land, but in times of shortage the landowner's groundwater extractions are limited to amounts that are reasonable with respect to the water needs of the other landowners overlying the basin.

Since overlying rights are private rather than public rights, cities overlying a groundwater basin can claim an overlying right only to the extent the water is used on overlying land that the city actually owns. In order to extract groundwater and serve it as a public water supply on private lands within the city's corporate boundaries, the city may acquire some other type of groundwater right, normally an appropriative right or prescriptive right.[18]

Public groundwater supplies are primarily secured by means of appropriative rights, which are acquired by simply extracting surplus groundwater that the overlying users do not need. However, the measurement of these surplus waters is difficult because of the annual characteristic of the hydrologic cycle. While most of the surface water supply is generally replaced each year by precipitation, groundwater supplies are not. The amount of water in an underground basin of any significant size vastly exceeds the amount of water that naturally percolates into the basin each year. This large amount of water has accumulated millennially and greatly antedates man's activities to extract it.

In Southern California prescriptive rights have, to a large degree, superseded both overlying and appropriative rights. Mutual prescription is a method for allocating shortages in an overdrafted groundwater basin. Under mutual prescription all groundwater extraction rights exercised during a prescriptive period of at least five continuous years are reduced to a common prescriptive rights classification. All groundwater extraction rights not exercised during the prescriptive period are lost. The remaining prescriptive rights are reduced on a pro-rata basis so that the total annual groundwater extractions equal the safe yield (i.e., the amount of new water percolating into the basin each year). The pro-rata reduction is based on the lowest annual amount of groundwater each entity extracted during the prescriptive period. Thus, all those entities extracting groundwater from the basin during the prescriptive period, whether they claim overlying or appropriative rights, are treated equally and independently of any priority dates, subject to public prescription priorities.[18]

A pueblo water right is the paramount right of a city, as the successor of a Mexican or Spanish pueblo, to use the water naturally occurring within the old pueblo limits for the inhabitants within the city's expanding boundaries.

Pueblo Rights for the City of Los Angeles: The Los Angeles River provided the sole supply for the Pueblo of Los Angeles and its successor City from the founding of the pueblo in 1781 through the 19th Century and the first decade of the 20th. The City's rapid growth from a population of 11,183 in 1880 to 318,198 in 1910 was accompanied by concern over the future water supply. The City obtained judgments declaring and enforcing its claim to a paramount pueblo right to use the water of the river to the extent of its needs. On the basis of serious water deficits during heat waves in the summers of 1904 and 1905, the City obtained an injunction prohibiting numerous landowners in the southeastern San Fernando Valley from extracting or diverting water at any time that Los Angeles was consuming the entire flow for its municipal supply.

Another response to the increasing water shortage was to obtain new sources of water, so the City of Los Angeles made minor additions to its Los Angeles River supply by the drilling of wells and the acquisition of private water systems. This was followed by the building of the LAA and the delivery of Owens River water in 1913. The San Fernando subarea was a semi-desert until the introduction of Owens water in May 1915.

In the Water year 1913-1914, despite the beginning inflow of Owens water, Los Angeles drew 62,800 acre-feet of groundwater from the ULARA. This amounted to almost the entire safe yield of the ULARA, and probably equalled or exceeded the safe yield of the San Fernando subarea. In the following year, 1914-1915, the City's extractions dipped to 49,630 acre-feet and did not again reach the annual rate above the 1913-1914 figure until 1923-1924.

The importation of Owens water created a surplus enabling others to make competing appropriations from the underground supply. The two responses by Los Angeles to the acute water shortage of the 1900s—obtaining judicial protection of its pueblo water right and importing water from the Owens River—were interrelated. In importing the water, the City relied on its pueblo right to retain priority in its original native supply once this surplus was exhausted.[11]

The record shows no previous action by Los Angeles against the taking of water from the Sylmar or Verdugo subareas. The Sylmar subarea includes 9 percent of the territory of the City of San Fernando. This originally contained substantial areas of cienegas, or marshes, watered by artesian springs. These cienegas supplied the water for the buildings and original settlement lands of the Mission of San Fernando which, in 1808, completed a dam to capture the Sylmar cienega waters and in 1811 completed a mile and a half of aqueduct to carry the water to its buildings and irrigation system. There is no record of any objection on the part of the Pueblo of Los Angeles to the Mission's use of these Sylmar waters.[11]

All water from wells in the Sylmar subarea is drawn from confined aquifers, that is, bodies of groundwater cut off from free hydraulic connections with overlying groundwater except at the intake. These aquifers reach 12,000 feet in depth, compared to the maximum of 1,000 feet of depth reached by the water-bearing materials beneath the San Fernando subarea. Between 1928 and 1958, there was an average underflow of 560 acre-feet of water per year through the Pacoima and Sylmar notches from the Sylmar subarea to the San Fernando subarea. It is estimated that in the absence of the Pacoima submerged dam constructed at Pacoima notch in 1888, this average underflow would have been 750 acre-feet. However, this flow did not emanate from the confined aquifers which supply the wells but from the groundwaters which supply those aquifers.[11]

The Verdugo subarea, located east of the Verdugo Hills and not contiguous to any subarea of the ULARA other than the San Fernando subarea, contains a large aquifer capable of furnishing a substantial water supply. From 1928 to 1959, there was no significant underflow of groundwater between the Verdugo and San Fernando subareas. This lack of underflow was apparently due to extraction of water from wells in Verdugo and the confining effect of a submerged dam constructed part way across the mouth of Verdugo Canyon in 1895 and reconstructed by the City of Glendale in 1935.

There is evidence that the Sylmar, Verdugo and San Fernando subareas are each separate basins, and their extractions of water in each basin affect the other water users in the same basin, but do not significantly or materially affect the groundwater levels in other basins. However, it appears that the lack of underflow between the basins is due in large part to the ongoing extraction of water through wells and that in a state of nature with no extractions, the Verdugo and Sylmar basins would in effect be filled to overflowing, causing water that they would otherwise receive to enter the San Fernando basin which supplies the Los Angeles River.[11]

Thus the City of Los Angeles sought to have its pueblo rights extended to include the Sylmar and Verdugo basins because the City contended that extractions in Sylmar and Verdugo diminish the Los Angeles River supply.[11] The California Supreme Court disagreed. The Court held that the pueblo rights did not extend to the groundwater in the Sylmar and Verdugo basins but that the pueblo rights did attach to native groundwater within the San Fernando basin and to surface water tributary to such groundwater.[11] In an earlier case[10] the Court did include within the pueblo right certain *surface* waters outside the San Fernando subarea. The Los Angeles Flood Control District had impounded flood waters in Pacoima and Big Tujunga reservoirs in the hill areas of the ULARA. If not impounded, much of these waters would in time of flood have rushed to the Pacific Ocean but when released from the reservoirs in a more orderly fashion some of the waters flowed into the San Fernando basin. These reclaimed flood waters were held subject to pueblo rights because the flood control district made no claim to them and they had been impounded from and returned back into streams that were natural tributaries of the Los Angeles River.[10]

The State Supreme Court decided in 1975 that Los Angeles has a pueblo right to all groundwater in the San Fernando basin "derived from precipitation in the ULARA insofar as it uses such water to satisfy its municipal needs and the needs of its inhabitants." Furthermore, Los Angeles has a right to all San Fernando basin groundwater derived from water which it imports from outside the ULARA "insofar as the city applies such derived water to reasonable beneficial uses."[11]

4.2.3 WATER RIGHTS OF LOS ANGELES VERSUS BURBANK AND GLENDALE. The Supreme Court also decided that "Glendale and Burbank each have a prior right to all San Fernando basin groundwater derived from water that such city imports from outside the ULARA and delivers within the ULARA insofar as the city applies such derived water to reasonable beneficial uses."[11] It should be noted that Glendale and Burbank, unlike Los Angeles, do not engage in spreading operations. Their imported water is all purchased from the MWD. Los Angeles imports relatively small amounts of MWD water into the basin in addition to its far larger imports of Owens water.

The Court held that Los Angeles' pueblo right and the respective imported water rights of Los Angeles, Burbank, and Glendale are mutually exclusive and of equal priority. All such rights are prior to rights dependent upon ownership of overlying land or based solely upon appropriation of groundwater from the basin. Thus all rights of Burbank and Glendale other than their imported water rights are subordinate to the foregoing rights of Los Angeles. The water rights of private parties are subordinate to those of the three cities.[11]

The California Supreme Court remanded the case of *City of Los Angeles v. City of San Fernando* [11] to the trial court (Superior Court) to adjudicate a new accommodation of San Fernando basin water rights between Los Angeles, Glendale and Burbank and to take into account separate judgments entered under stipulations between Los Angeles and certain defendants who were not parties to the appellate action.

The Court directed that the San Fernando basin's safe yield should be apportioned between amounts attributable to (1) native waters produced by precipitation within the ULARA, and (2) water imported from outside the ULARA. "This latter amount should in turn be apportioned among the respective quantities derived from imports" by Los Angeles, Glendale, and Burbank. Los Angeles "should be awarded an unadjusted pumping right to the portion of safe yield derived from native waters and from its own imports, and Glendale and Burbank should each be awarded an unadjusted pumping right to the portion of the safe yield attributable to its own imports."[11]

According to the findings of the State Water Resources Control Board as referee in the case of *City of Los Angeles v. City of San Fernando*,[11] 40 percent of the safe yield of groundwater from the San Fernando basin during the water years 1949-1950, 1954-1955, and 1957-1958 was derived from water imported from outside the Los Angeles River watershed (Table 4-5). Most of this delivered water was imported by the City of Los Angeles from Owens Valley and Mono basin; the remainder was Colorado River Water purchased by Los Angeles, Glendale and Burbank from MWD. The acre-feet of Owens water spread by Los Angeles amounted to 8,453 in 1949-1950, 10,867 in 1954-1955, and 6,278 in 1957-1958. These amounts of water spread by Los Angeles for direct recharge of the basin are relatively small compared to the total amount of imported water entering the groundwater (Table 4-5). The referee's report shows that some portion of the water delivered in the basin for practically *any* type of purpose, urban or

Table 4-5. Annual safe yield in acre-feet, San Fernando basin.

WATER YEAR	1949-1950	1954-1955	1957-1958
Safe Yield Derived from Average Import	37,020	40,470	40,300
Safe Yield Derived from Normal Native Supply	54,390	50,440	47,500
Total Safe Yield of San Fernando Basin	91,410	90,910	87,800
Owens Water Delivered by Los Angeles	142,710	151,030	156,310
Colorado (MWD) Water Delivered by:			
Glendale	270	780	1,260
Burbank	210	1,430	3,320
Los Angeles[1]	480	6,530	7,050
Owens Water Spread by Los Angeles[2]	8,453	10,867	6,278

[1] All MWD water delivered by Los Angeles in the San Fernando Basin went to the Narrow's Service Area which is south of the City of Glendale.

[2] Glendale and Burbank do not engage in spreading operations.

agricultural, reaches the ground supply. The return flow attributable to delivered imported water reaches the ground as waste, seepage or spillage, or by similar means in the course of use. Commercial and industrial users may contribute to this supply by applying water to landscaped areas or disposing of wastewater in unlined sumps or channels or in cesspools. To ascertain the proportion of delivered water which was recharged into the underground basin, the referee made detailed studies of such conditions as soil, climate, native vegetation, farming operations, and residential and commercial development prevailing in the area during each of the water years for which safe yield was determined (Table 4-5).[11]

The matter of determining "safe yield" was left to the lower court on remand. In 1964-1965, Los Angeles extracted 107,800 acre-feet from the San Fernando basin which was 17,120 acre-feet more than the basin's safe yield. "The trial court may deem the present safe yield to be equal to that already found to exist under 1964-1965 conditions or on proper showing it may determine the amount of the safe yield under conditions of a more recent year."[11]

Although by far the largest share of the basin's supply is allocated to Los Angeles, the Supreme Court felt that Burbank and Glendale had sufficient interest in maintaining the basin supply to warrant restrictions on Los Angeles. This stemmed from the rights of Glendale and Burbank to recapture the return flow attributable to their imports, "which will probably increase as a result of (1) [their] substitution of imported water for the ground supply relinquished in deference to [Los Angeles'] prior rights and (2) the overall expansion of their total water needs. The exercise of the return flow right would become more difficult and eventually impossible if the basin levels were continually lowered by an excess of extractions over safe yield."[11]

"A continual lowering of ground basin levels would also interfere eventually with any pumping permitted by the judgment as part of a physical solution or for nonconsumptive uses."[11]

The Supreme Court said that "the new judgment should provide for adjustments in each party's pumping right to be administered by the watermaster under supervision by the court." The Court held that Los Angeles' pumping rights should be adjusted to take into account the imported water which it spread and also the stipulated judgments that Los Angeles had entered into with several private defendants who were not parties to the appeal. Two of these "stipulating defendants" operated air conditioning systems and three produced rock, sand, and gravel. These particular uses of extracted water are unique in that most or all of such water is returned to the ground after use and so is nonconsumptive. These "stipulating defendants" are permitted to continue their extractions only as long as they do not alter their manner of use in a way that increases its consumptive effect. The Supreme Court found merit in Los Angeles' argument that the gross extractions by these "stipulating defendants" should not be charged against the Los Angeles pumping rights but instead the charge should be only an amount which reflects the net impact of those extractions. Because of these extractions, 4,150 acre-feet were deducted from the 1972-1973 Los Angeles pumping rights.

The Court also directed that the Los Angeles pumping rights should be credited with the return flow derived from its spreading of imported water. The amount of credit for any such spreading should take "into account any losses from evaporation or otherwise that may be caused by the spreading operations."[11]

The Court said that the pumping rights of Glendale and Burbank should be adjusted to credit them with increases in the return flow derived from the imported water they deliver to the basin.

> Such return flow is likely to increase as imported water is substituted for the groundwater which must be relinquished to [Los Angeles]. To provide for this credit, the trial court should determine (1) the annual rates of deliveries of imported water by Glendale and Burbank respectively which were assumed in computing the safe yield and (2) the amount of increase in the basin's groundwater supply attributable to such deliveries by each [city] calculated as a percentage of such delivers.

The trial court was given discretion to incorporate facilitative provisions which would provide flexibility in the administration of the quantitative pumping restraints.

The Supreme Court suggested that the trial court consider a physical solution to the San Fernando basin rights between Los Angeles, Glendale, and Burbank.

> The usual purpose of a physical solution is to avoid a waste of water without unreasonably or adversely affecting the rights of the parties. Both [Glendale and Burbank] have made substantial investments in groundwater extraction and distribution facilities[10] and it is possible that a strict limitation on their extractions and their consequent increased dependence on imported water would require large expenditures for new and different facilities. It is also possible that a physical solution might avoid the necessity for some or all of these expenditures without imposing any substantial burden on [Los Angeles]. Such a solution might, for example, embody an exchange arrangement whereby under appropriate safeguards [Glendale or Burbank] would furnish [Los Angeles] with imported water in return for added groundwater rights equivalent to (1) the quantity of such imported water plus (2) the quantity of the return flow rights [Glendale or Burbank] would have received if it had delivered the imported water to its own territory in the basin. Whether this or any other solution is fair and just to all parties and interests concerned can only be determined by the trial court from the record and from any additional showing or evidence that may be offered and received after remand and nothing we say should be deemed restrictive of the trail court's equitable discretion in this regard.[11]

The Supreme Court held that Los Angeles "has a prior right to the return flow derived from its deliveries of water it imports into the Sylmar basin from outside the ULARA, similar to such return flow in the San Fernando basin". However, the Los Angeles pueblo right, applicable to the native waters of the San Fernando basin does not extend to Sylmar basin native waters. Similarly the court rejected Los Angeles' claim that its pueblo right extends to the Verdugo basin. "Although [Los Angeles] delivers imported Owens water to the part of its Sunland-Tujunga service area located within the basin (it) has never extracted groundwater from the basin and apparently has no facilities for doing so."

4.2.4 UNDERGROUND WATER STORAGE RIGHTS. In analyzing "underground" storage" rights it is important to distinguish them from the groundwater rights discussed above. One of the important aspects of the Supreme Court's decison[11] is that storage rights for the public do *not* depend on groundwater rights. "While it is tempting to assume that the right to store water in an underground basin is merely the inverse of the right to take native groundwater out of that basin, there are practical reasons why storage rights and water rights should not be considered reciprocal. The most compelling reason is that the two rights refer to significantly different physical operations."[18]

Storage requires obtaining another water supply that would not normally percolate into the underground basin and mintoring its percolation. Although the right to store water underground implies the right to control the manner in which the water is extracted from storage, extracting stored water originally obtained from an otuside source involves different types of risks and responsibilities than does the simple extraction of native water. Finally, placing water underground for storage is much more expensive than merely extracting it.[18]

The Supreme Court has in effect judicially established several public rights that, taken together, now represent the general underground storage right. These are of critical importance if California is to realize the full potential of its groundwater basins:

1. The right to store water in a natural underground basin without compensating overlying landowners;
2. The right to protect the stored water from expropriation by others and from inequitable operational burdens; and
3. The right to recapture the stored water when it is needed.[18]

4.2.5 PRESENT AND PROPOSED RECHARGE BY SPREADING. "A key point in the Supreme Court decision is that Los Angeles may extract an amount of water equal to the amount of imported water it spreads. This is likely to be applicable to reclaimed water as it is primarily of imported origin."[7]

This decision thus frees the City of Los Angeles to increase its storage of imported and reclaimed water in the groundwater of the San Fernando Basin if the health and economic constraints can be overcome. Before the Supreme Court rendered its decision the annual extractions were limited to 58,600 acre-feet per year by the trial court's earlier ruling. Now the Supreme Court's decision[11] could result in an annual extraction of approximately 83,000 acre-feet from the San Fernando Basin, plus the amount of water intentionally spread. This use of reclaimed water would permit surplus storage to accumulate for withdrawal during drought periods or as an emergency supply.

Surface spreading for groundwater recharge is the method which involves the least cost and has the greatest history of practice. This is accomplished in California by impounding water in low leveed basins or ponds constructed upon soils having good permeability. The shape and size of the basin are such that the wetted area to gross land area is maximized while permitting the best operational cycle to provide for flooding and resting.[6] The San Fernando Valley is the only area within the City of Los Angeles which is suitable for groundwater recharge by spreading.[7] The favorable geological conditions have resulted in significant development of the groundwater resources in the eastern section of the valley. In addition to possessing a large majority of the basin's producing wells, the eastern section also contains all of the artificial recharge areas in the basin.

There are six such recharge areas in the San Fernando basin. The Los Angeles County Flood Control District operates the Branford, Hansen, Lopez, and Pacoima spreading grounds. The Los Angeles Department of Water and Power operates the Headworks and Tujunga spreading grounds. In addition, incidential recharge occurs in two unlined reaches of the Los Angeles River, one near Griffith Park and the other in the Sepulveda basin. The Headworks, Pacoima, and Tujunga spreading grounds as well as the lower unlined reaches of the river could conceivably accept reclaimed water for recharge. The maximum potential capacity for recharge based on the physical constraints of these spreading grounds along with the unlined reaches of the river is approximately 290 cfs, or 210,250 acre-feet.

In all likelihood, the Pacoima Spreading Grounds operated by the Flood Control District will continue to be used for the recharge of storm waters, but not for reclaimed water. Under both of the proposed wastewater management plan alternatives ("B" upstream and coastal, "E" maximum reclamation) the planned Sepulveda facility would treat the wastewater which could be used for groundwater recharge if health constraints are overcome. Transport to the Tujunga Spreading Grounds would be by pipeline while the reclaimed water could be conveyed to the Headworks Spreading Ground either by pipeline or open channel via the Los Angeles River. If both Tujunga and Headworks spreading are used, then the physical capacity for recharge of reclaimed water would be as much as 173.5 cfs or 125,800 AF/yr (Table 4-6).

However, the controlling factor in the amount of reclaimed water that can be reused is the current well extraction capacity. The City of Los Angeles has seven well fields in the San Fernando basin which are being used for domestic supply. As shown in Table 4-6, the combined capacity of these wells is 232 cfs. The extractions from these wells have averaged 80.3 cfs during the years 1969-74 which corresponds to the rights of the City as adjudicated by the Superior Court. However, under the 1975 ruling by the Supreme Court it is possible that these extractions could increase to 115 cfs. This would result in a future excess well capacity of about 117 cfs which could be used to recapture imported water or reclaimed water from the recharged groundwater (Table 4-6).

Table 4-6. Available capacities of LADWP facilities to utilize reclaimed water.

FACILITY	AMOUNT OF WATER SPREAD/EXTRACTED	
	CFS	AF/Yr
Spreading Grounds[1]		
Total Capacity	185.0	134,100
Current Operations[2]	11.5	8,300
Excess Capacity	173.5	125,800
Well Field Extraction		
Total Capacity	232.0	168,200
Current Operations[2]	80.3	58,200
Reserve Capacity[3]	34.2	24,800
Excess Capacity	117.5	85,200

[1] Includes Headworks and Tujunga Spreading Grounds. Additional recharge occuring in the unlined reaches of the Los Angeles River is a function of the amount of water flowing in the channel.

[2] Five-year average for 1969-1974.

[3] Required for anticipated increased pumping as a result of State Supreme Court decision on water rights in ULARA.

Under the "physical solution" suggested by the Supreme Court[11] (see above discussion) the Cities of Glendale and Burbank may be allowed to pump groundwater in excess of their rights in exchange for Los Angeles taking the imported water these cities would normally require because of their decreased water rights. Thus the excess well capacity in Table 4-5 could increase if physical solutions with Glendale and Burbank reduce the amount of native water extracted by Los Angeles.

It should be noted that the California Department of Water Resources and other water agencies plan a conjunctive use of the groundwater basin as a storage reservoir for surplus water from the State Water Project (SWP). Tentative plans call for spreading 300,000 acre-feet of SWP water over a five-year period. This proposed conjunctive use may have an effect on the amount of reclaimed water that could be spread due to higher water table elevations. However, the San Fernando basin has a substantial usable storage capacity estimated at 500,000 acre-feet. In Addemdum I[7] it is assumed that 70 cfs of reclaimed water would be spread by the City of Los Angeles to recharge the San Fernando groundwater basin. The basin has been overdrafted so about 20 cfs of the 70 cfs reclaimed water delivered to the spreading ground is for replenishment. The storage capacity of the basin is sufficient to accept the excess replenishment for many years.[7]

4.3 Effect of Reclaimed Water Recharge on Quality of the Water Supply

The water extracted from the recharged groundwater is for domestic consumption so the effect of reclaimed water on domestic water quality and its disposition in the distribution system are very important considerations. It must be restated and emphasized that there are no reclamation criteria presently established for domestic use of reclaimed water because information relative to health effects from ingestion is uncertain and the interval involved before conclusive information is available may be considerable.

The water quality at the customer's tap depends upon the location, amount, and quality of reclaimed water that is spread, the travel time in the groundwater, the dilution in the groundwater, the location and amount of well extractions, the treatment after extraction, and the dilution in the distribution system. By analyzing the groundwater and distribution systems, a determination of the amounts of reclaimed water reaching the customer's tap can be made.

The native or local groundwater in the San Fernando Valley is a water type which has a variable water quality. As the local groundwater moves in an easterly direction through the Valley, deposits in the saturated zone decompose or leach out to affect the local groundwater quality. In addition, pumping of the well fields in the eastern half of the Valley has increased the west-to-east gradient. Thus, pumping has caused the poor quality groundwater in the western half of the basin to flow into the eastern well fields and raise the TDS concentration of the pumped waters.

The local groundwater in Table 4-7 is assumed to have zero percent reclaimed water, but, to a small extent, waters from septic tanks, landfill leachates, and industrial discharges injected underground in past years do reach groundwater.

The chemical characteristics of interest to the State Department of Health, specifically the indicators of gross organics pollution (BOD, COD, CCE, TOC), are included in Table 4-7. The CCE and COD parameters vary significantly between water types and this gives a clear picture with respect to gross organics of how blending affects resultant water quality. The TDS parameter is the best indicator available for the general chemical quality of the water blends.[17]

Determinations have been made as to the disposition of reclaimed water in the City of Los Angeles Water System (Table 4-8). Water infiltrating in the unlined reaches of the Los Angeles River is recovered at the Crystal Springs and Pollock well fields. Water spread at Headworks is extracted from the Headworks and Crystal Spring Wells. Water spread at Tujunga is recovered at the North Hollywood well field. All water extracted from these wells normally flows to the River Supply Conduit (RSC) which serves a population of approximately 500,000. Under conditions of increased demands or increased pumping from the North Hollywood Wells, water could also be diverted to the Hollywood Reservoir which serves a separate area of the City from that of the RSC of approximately 600,000. The actual amounts of reclaimed water served would depend on the level of reclamation being pursued.[12]

A 1975 report[17] indicates that 100 percent of the water spread at the Tujunga Spreading Grounds is assumed to be tributary to the North Hollywood Well Field. According to the report and assuming no carbon adsorption treatment of effluent, spreading 45 cfs of Sepulveda facility reclaimed water at Tujunga could result in a significantly lower water quality served to Los Angeles customers as compared to the current operation. However, primary drinking water standards would likely still be met. The degradation of water quality would result from the North Hollywood wells operation which would introduce the reclaimed water into the River Supply Conduit.

The 1975 report[17] also analyzed the situation which would result if the Headworks Spreading Ground were operating at its maximum of 35 cfs spread as follows:

> The percent reclaimed water, CCE, COD and TDS served to all the customers is directly related to the amount of water spread at Headworks Spreading Grounds (HSG). In general, the more water spread, the lower the water quality served to the customers. However, operation of HSG in the range of zero to 10 cfs does not appear to significantly influence the water quality served to Los Angeles or Glendale. With HSG shut down, the gross organics concentration is equal or lower than that which is currently served.[16]

Table 4-7. Water type characteristics in the San Fernando Valley Basin.

WATER TYPE	CHEMICAL CHARACTERISTICS					
	CCE* (µg/l)	COD (mg/l)	BOD (mg/l)	TOC (mg/l)	TDS (mg/l)	PERCENT RECLAIMED
Los Angeles River[1]	500	20	5.5	—	840	0
Burbank Western Wash[7]	550	25	1.0	—	600	66
Sepulveda Effluent[2] (predicted)	400	20	5.0	—	500	100
LAGWRP Effluent[2] (predicted)	400	20	5.0	—	500	100
Los Angeles River (Extracted From Groundwater)[3]	250	15	2.0	—	860	0
Groundwater (SWRP & LAGWRP Effluent That Deep Percolated In LAR)[4]	200	15	2.0	6.5	530	100
Los Angeles Aqueduct Water[5]	50	4	1.5	—	180	0
Local Groundwater[6]						
Verdugo, North Hollywood, Whitenall, and Erwin Wells	20	2	2.5	4.7	450	0
Headworks Wells	20	2	2.5	4.7	650	0
Crystal Springs Wells	20	2	2.5	4.7	650	0
Grandview Wells	20	2	2.5	4.7	450	0
Pollock Wells	20	2	2.5	4.7	750	0

[1] DWP data 1974 LAR at the HSG diversion, CCE estimated.

[2] COD from NPDES permit, estimated CCE, no additional treatment by DWP.

[3] Estimated CCE removal = 50 percent, COD removal = 25 percent, TDS based on 1971-1972 DWP Data LAR at HSG diversion and Deep Gallery Wells.

[4] DWP data 1975, Headworks Test Basin Study, CCE estimated.

[5] DWP data 1970-1975, Upper Van Norman Inlet, TDS = .63 x sp. cond.

[6] DWP data, Arleta Well 1966-1974 for COD, CCE, BOD, TOC, reference No. 7 for TDS data.

[7] DWP data 1974 for TDS, BOD, COD based on 1975 grab sample, CCE estimated percent reclaimed based on 1972-1973 Watermaster Report and conversation with City of Burbank personnel.

*CCE sampled by high-flow carbon adsorption method.

Table 4-8. Underground movement of deep percolated water.

SPREADING SITE	EXTRACTION SITE	% INTERCEPTED*
Tujunga Spreading Grounds	North Hollywood Wells	100%
Headworks Spreading Grounds	Headworks Wells	100%
Zone 1 Unlined Section of LAR	Crystal Springs Wells	30%
Zone 1 Unlined Section of LAR	Grandview Wells	70%
Zone 2 Unlined Section of LAR	Crystal Springs Wells	30%
Zone 2 Unlined Section of LAR	Grandview Wells	70%
Zone 3 Unlined Section of LAR	Pollock Wells	100%

*It is recognized that the "percent intercepted" is a function of the deep percolation flows of a particular reach and of the amount of water pumped from the extraction site. Although a major change in pumping pattern is not anticipated, any such change would be expected to reduce the proportion of reclaimed water pumped by the Grandview Wells. Thus the resulting percent reclaimed water figures in this evaluation are conservative.

The analysis assumes steady state conditions have been reached between the reclaimed water being recharged and the normal groundwater flow adjacent to the well fields of interest. But in some cases, steady state conditions may not occur for 25 years.[17] (Table 4.9).

Table 4-9. Travel distance and time of deep percolated waters.

WATER SPREADING SITE	EXTRACTION WELL SITE	TRAVEL DISTANCE (FEET)	ESTIMATED TRAVEL TIME
Headworks Spreading Grounds	Headworks Wells	3,000- 4,000	4 years
Headworks Spreading Grounds	Crystal Springs Wells Grandview Wells	6,000- 9,000	10 years
Tujunga Spreading Grounds	North Hollywood Wells "OTHER WELLS"	9,000-14,000	10-20 years
L.A. River, Zone 1 unlined Section	Crystal Springs Wells Grandview Wells	1,000- 2,000 2,500- 4,000	1-2 years 2-4 years
L.A. River, Zone 2 unlined Section	Crystal Springs Wells & Grandview Wells	5,000-18,000	7-25 years
L.A. River, Zone 3 unlined Section	Pollock Wells	500- 8,000	<1-5 years

> The L.A. Zoo and Glendale would receive the lowest water quality with HSG operating at its maximum of 35 cfs spread. Headworks Wells can intercept an amount of water spread at HSG that is equal to its maximum pumping rate of 24 cfs. With 35 cfs being spread at HSG, deep percolated water in excess of 24 cfs would flow past Headworks Wells and would be intercepted by Crystal Springs and Grandview Wells. This additional flow of water further lowers the water quality pumped by these two wells. The impact on the L.A. Zoo could be minimized by serving the zoo from the RSC rather than by its current tap off the Crystal Springs Wells.[17]

A different TDS result was reached by a 1976 study[12] also by the DWP which concluded that in terms of salinity (TDS) there would be no adverse impacts on groundwater quality from spreading Sepulveda reclaimed water at Tujunga.

Although no adverse impacts are anticipated with respect to salinity considerations, the health aspects of water reclamation involving the ultimate domestic use of reclaimed water currently prevent its use for groundwater replenishment. The State Department of Health has raised questions about the health effects of ingesting reclaimed water in terms of the potential toxic effects of organic compounds and heavy metals, and the presence of virus in the water as discussed earlier.

The DWP has agreed to discontinue the diversion of Los Angeles River water at the Headworks Spreading Grounds when (and if) Sepulveda effluent is discharged to the Los Angeles River. Under the present operations, a certain portion of the Los Angeles River flow infiltrates into the groundwater basin through the unlined sections of the riverbed. In addition, for several years, approximately 10 cfs of flow have been diverted from the Los Angeles River Channel for infiltration into the groundwater basin through the Headworks Spreading Grounds.

In a meeting in Sacramento on 18 July 1975, Mr. Henry J. Ongerth of the State Department of Health expressed the judgment that because of uncertainties regarding the concentration and identification of organics which may exist in the treated effluent it would be unacceptable to infiltrate water through the Headworks Spreading Grounds which contained *any amount* of treated wastewater from Sepulveda, but that it would be acceptable for the groundwater basin to receive the amount of reclaimed wastewater that would infiltrate through the unlined river channel.

This was agreed to by the Los Angeles Department of Public Works in a letter from Paul H. Lane, Chief Engineer of Water Works, to the State Water Resources Control Board on 5 August 1975. However, the Department indicated that it was conducting investigations to better understand the organics in treated wastewater, particularly as such waters are infiltrated through the soil mantle into a groundwater basin.

> The State Water Resources Control Board, and the State Departments of Water Resources, and Health have signed a Memorandum of Understanding to establish a consulting panel on Health Aspects of Wastewater Reclamation for Groundwater Recharge. The Panel will bring together

knowledge and judgments of a recognized interdisciplinary group of experts to be used in identifying the research needs to determine the health effects which may be associated with reuse of water and to aid in developing reclamation criteria necessary to protect public health. The ultimate goal is the development of the regulations for groundwater replenishment with reclaimed water. This information will be updated when available.

Until such time as these health questions have been answered, groundwater replenishment by spreading with reclaimed water will not be implemented although feasibility studies will continue. It is currently estimated that groundwater replenishment by spreading will be implemented by 1990, allowing 10 years to resolve the questions of health effects and feasibility and 4 years to design and construct facilities.[12]

4.4 Other Potential Secondary Impacts of Recharge of Reclaimed Water

It is assumed that the spreading activity will continue to function and accept the proposed quantity of reclaimed water. However, it should be noted that the method of groundwater recharge by surface spreading is dependent upon many factors. These include the type of soils, depth to groundwater, area available for recharging, geographical location, and the quality and quantity of treated wastewater available. For spreading of treated wastewaters to be effective in recharging the groundwater, the wetted surface of the soil must remain aerated and unclogged. Surface area should be such as to minimize evaporation while maximizing infiltration, the quality of the wastewater should be such as to minimize the inhibition of infiltration, and operational procedures should maximize the quantity of actual groundwater recharge while optimizing the quality of the wastewater reaching the groundwater body through the removal of contaminants by soils and sediments. Management of spreading grounds is such that clogging of soils would not be expected during the project's lifetime.

Increasing storage in the aquifer will raise the groundwater level. However, the increment of 20 mgd which is not intended for withdrawal, is to replace water already removed from the aquifer. There is considerable storage capacity in the aquifer that can be utilized before any adverse effects of the rising groundwater level would be expected.

Energy use for water supply is increased by underground storage of water because of the need to pump supplies out of the aquifer. For the storage of stormwater, the energy disadvantage is offset by the need to store water from temporary excesses that would otherwise flow into the ocean and be lost. For reclaimed water, produced at a relatively constant rate, underground storage is not needed to equalize the volume available for distribution. However, the process of infiltrating through soil layers, and the time interval between reclamation and reuse, probably contribute to improvement in the quality of the water. The exact changes that result from infiltration and underground storage of reclaimed water are poorly understood, but it is likely that an equal degree of treatment in aboveground facilities would require more energy than does the pumping needed to withdraw groundwater.

Groundwater recharge of reclaimed water, if implemented as proposed, will result in larger volumes of water available locally at any particular time. This would be an advantage should some disaster result in the interruption of water imports to the City, or in case imports are reduced due to water shortages throughout the state.

The storage and recapture of reclaimed water from the San Fernando basin would tend to reduce the need for increased amounts of expensive MWD water in the future. This in turn would ease the burden on MWD by helping to defer demands for any future and highly expensive facilities to import additional supplies of supplemental water.[3] The annual storage of water for basin replenishment would provide the City of Los Angeles with a degree of insurance against drought-induced shortages and emergencies and permit long-range planning for the best use of a more stable and reliable water supply. The demonstrated uncertainties of the amounts of water available for import to Southern California emphasize the need for the City to protect its supply by additional storage of reclaimed water. An example of unanticipated reductions in the amount of water available for import is a recent court order requiring the City to provide 70,000 acre feet of water during six months of 1977 to Owens Valley ranchers instead of the 50,000 acre-feet that the City had offered.[13] Furthermore, litigation still continues over claims for Colorado River water. Although the Supreme Court in 1964 allocated 4.4 million acre-feet a year to California, 2.8 million acre-feet to Arizona and 300,000 acre-feet to Nevada, a dispute has arisen over Indian claims to Colorado River water. The Indian claims could amount to 40,000 acre-feet of water a year over the amount allocated to them in 1964. The outcome of this litigation could influence the long-term supply of Colorado River water available to MWD.[14] The cessation of pumping State Water Project water by MWD during 1977 and the temporary diversion of such water to Marin County in response to drought-induced shortages is another example of the uncertainties involved with imported water and further demonstrates the value of the maximum use of reclaimed water. The reliance upon imported supplies is also vulnerable to natural or man-caused disasters, and the sudden destruction of aqueducts, pumps, power supplies, or shortage facilities for imported water would be catastrophic. In such a situation a stored and replenished groundwater supply would be vital for domestic uses.

4.5 Review of the Proposed Use of Reclaimed Water for Groundwater Replenishment

In review, the sources of water presently used in Los Angeles are primarily the Owens River Aqueduct (approximately 77 percent) with local well water supplying about 19 percent and a blend of water from the

Metropolitan Water District constituting the remainder. Wells tapping the groundwater in the San Fernando basin currently provided about 15 percent of the water supply for Los Angeles.[7]

The mean annual water demand for the City of Los Angeles in the year 2000 is estimated at 900 cfs. This demand would be served from the Los Angeles Aqueduct (Owens River Aqueduct), local groundwater production, and Metropolitan Water District supplies with MWD supplying the increased future demands. Reclaimed water which is spread and recaptured in the San Fernando basin could be used to supplant some of the MWD water used in the system.[7]

In Addendum I it is assumed that 70 cfs of reclaimed water would be spread to recharge the San Fernando groundwater basin. The basin has been overdrafted so about 20 cfs of the 70 cfs reclaimed water delivered to the spreading grounds is for replenishment. This is roughly the equivalent of a total of 50,750 acre-feet of reclaimed water used to recharge the basin of which 36,250 acre-feet would be recaptured and 14,500 acre-feet would be used for replenishment. The San Fernando basin has a substantial usable storage capacity estimated at 500,000 acre-feet which is sufficient to accept the excess replenishment for many years.

Under both of the proposed wastewater management plan alternatives ("B" upstream and coastal, "E" maximum reclamation)[7] the spreading operation for groundwater recharge would be the same. The source of the reclaimed water would be the proposed Sepulveda facility. If health aspects can be resolved then there is a possibility that reclaimed water could be spread at the Headworks spreading grounds or at Tujunga spreading grounds.

There are presently no reclamation criteria issued by the State Department of Health for the use of reclaimed water for groundwater recharge by spreading. These have not been issued because of (1) the uncertainties over the fate of viruses in such use of reclaimed water, and (2) the possible health risks from stable, refractory organics. These constraints delay the implementation of groundwater replenishment by spreading reclaimed water, for it is estimated that it will take 10 years to resolve the questions of health effects and feasibility and 4 years to design and construct facilities, assuming the effluent quality is adequate. Therefore with potential implementation not expected until about 1990 the secondary impacts are not accurately predictable, especially in view of an anticipated decade of major socioeconomic adjustments to changing energy supplies and increasing demands on the state's water resources.

5. POTENTIAL SECONDARY IMPACTS OF USING RECLAIMED WATER AS THE SEAWATER INTRUSION BARRIER SUPPLY

During the early part of this century the rapid industrial and urban growth in the West Coast and Central Basins of Southern California (Figure 5-1) forced a dramatic increase in groundwater development. The extraction of groundwater eventually exceeded the actual replenishment of the basins and this overdraft caused seawater to flow into the confined aquifers of the basins. This was clearly indicated by receding groundwater levels and expanding areas of seawater intrusion.

By court order the groundwater extractions in the basins is limited to 64,468.95 acre-feet per year, and the State Department of Water Resources is the court-appointed Watermaster to enforce the order.

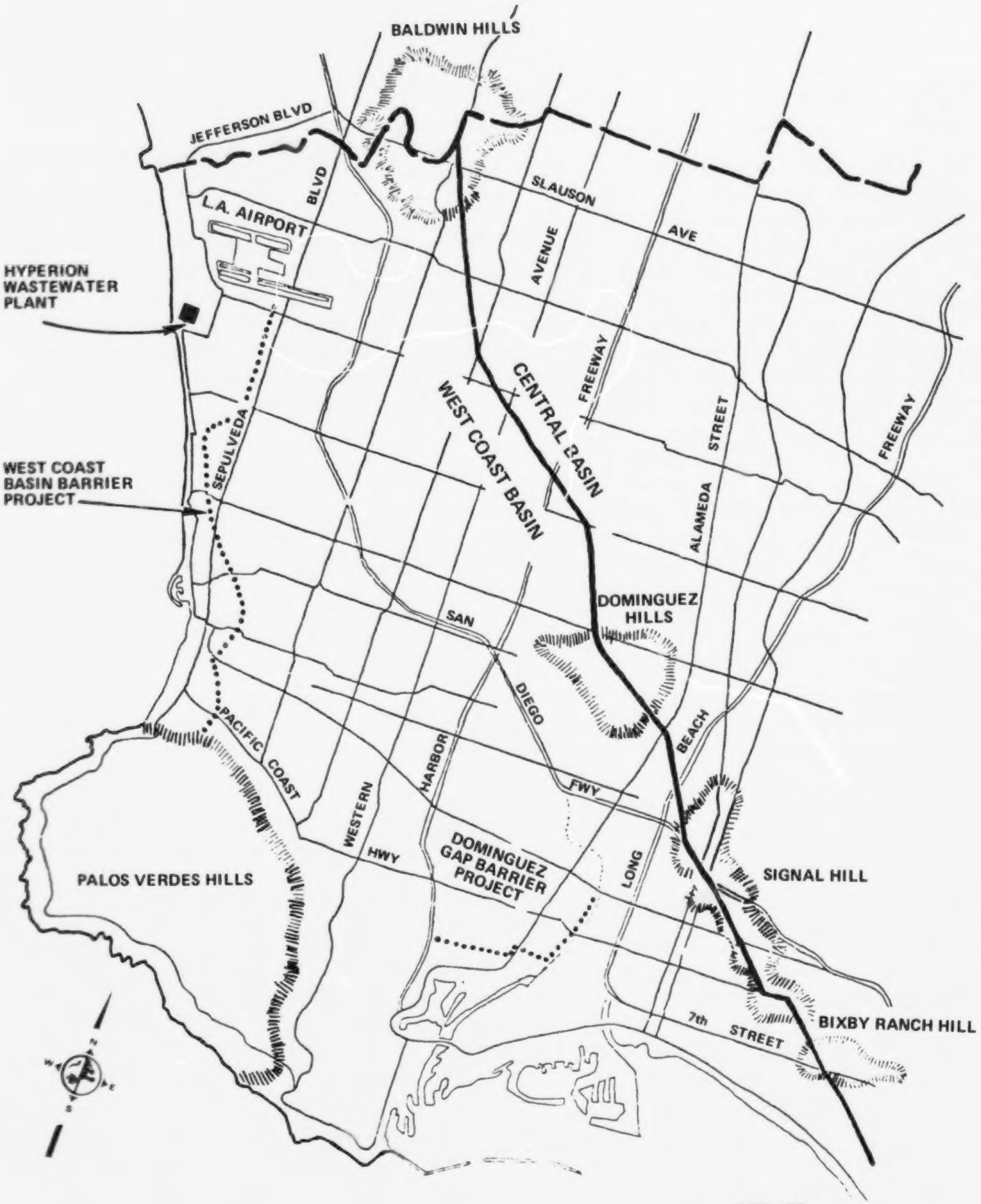
Tests were begun in 1953 on an experimental injection barrier which halted seawater intrusion along a one-mile front parallel to the Santa Monica Bay coastline. This led to the design and construction of the nine-mile West Coast Basin Barrier Project (Figure 5-1). This installation is a series of injection wells, supply pipelines and other facilities located parallel to the coastline between Los Angeles International Airport on the north and the Palos Verdes Hills on the south. The water injected into the aquifer creates a freshwater pressure mound which prevents the flow of seawater into the aquifer.

Imported water from the Colorado River and later water from the State Water Project has been the barrier supply throughout its operation. The increasing costs of this MWD water led to the consideration of reclaimed water as a substitute barrier supply.

5.1 Constraints to Implementation

Several major constraints are hindering the development of this project. These include public health concerns which are essentially the same as those for groundwater replenishment except that direct injection potentially creates more health risks than are involved in reclaimed water that is spread in basins and slowly percolates and infiltrates into the groundwater bearing strata.

Another constraint is the lack of funding for demonstration studies, for it is necessary to conduct a number of studies to show that reclaimed water can be used in the barrier with no adverse effects. Until this funding problem is resolved, no further development is anticipated.[12]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JEFFERSON BLVD
BLVD
SLAUSON
AVE
L.A. AIRPORT
HYPERION WASTEWATER PLANT
AVENUE
FREEWAY
CENTRAL BASIN
WEST COAST BASIN
SEPULVEDA
STREET
FREEWAY
WEST COAST BASIN BARRIER PROJECT
ALAMEDA
DOMINGUEZ HILLS
SAN
DIEGO
BEACH
PACIFIC
COAST
HARBOR
FWY
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Figure 5-1. West coast basin.

5.2 Projected Water Quality and Cost Impacts

The estimated water use for the barrier for 1976-1977 is 33,000 AF/Yr (30 mgd or 45 cfs) as a result of recently constructed additional injection wells. Estimates for reclaimed water use made in 1974 were for 39,000 AF/Yr (35 mgd or 54 cfs) and a cost analysis was based on this amount.[7]

In 1972 the cost for Colorado River water purchased at the replenishment water rate was $32 per acre-foot, but expected price increases by MWD were anticipated to raise the price of this water to about $70 per acre-foot, or higher. Thus, reclaimed water initially appeared to be a feasible alternative, but a reevaluation in 1974 based on new data changed this view. This 1974 evaluation indicated a number of potential water quality problems with the reclaimed water alternative which required higher levels of treatment than previously anticipated to provide the necessary reliability. Consequently, the estimated cost to treat and deliver reclaimed water to the barrier increased to a range of $73-$113 per acre-foot.[7]

In 1972, it was determined that the Replenishment District would pay $45/AF for reclaimed water used in the barrier during the demonstration studies. However, the evaluation in 1974 indicated that the cost of reclaimed water for these studies would be in the range of $135-$155 per acre-foot. This increase was the result of (1) a significant expansion in the scope of the studies to satisfy health concerns, (2) reductions in the anticipated amounts of grant funding, (3) equal sharing of the development costs between the Department of Water and Power and the Central and West Basin Water Replenishment District, and (4) inflation.

The Replenishment District decided that the monetary cost of the proposed reclaimed water supply to the barrier was no longer favorable so further development of the project was suspended. If these problems of funding and water quality are resolved in the future, a potential reclaimed water use up to 35 mgd (39,000 acre-feet) could be developed from the Hyperion Treatment Plant. A 1976 report[12] stated that "these problems are expected to delay development of the project until 1990." However, the March 1977 report[7] states that "At this time, it appears that funding of the project will continue to be a major problem that cannot be resolved."

The expected high power cost involved in importing state project water may raise the cost of this state water to about $100 per acre-foot in the mid-1980s. The incremental cost of Colorado River water prior to full operation of the Central Arizona Project may be in the range of $50 to $60 per acre foot (in 1976 it was $42 per acre-foot).[3]

The barrier project will continue to be an expensive operation regardless of the source of water supplied to it. Under the present constraints, the use of reclaimed water is indefinitely delayed and the uncertainties of the next decade with anticipated shortages of energy and increased demands for high quality water preclude reliable assessments of the possible nature of the project and related impacts.

6. POTENTIAL SECONDARY IMPACTS OF USING RECLAIMED WATER FOR INDUSTRIAL SUPPLIES

The principal use of reclaimed water as an industrial water supply is for cooling tower makeup with smaller amounts for boiler feed water and process water. If an area has a particularly small use or is a significant distance from a wastewater treatment plant, it is realistically eliminated as a potential industrial market for reclaimed water. Information on potential industrial water uses was developed in Addendum I (LACWFP).[7] The amounts of water potentially used by industries are particularly sensitive to the locations of industries with respect to the reclamation facilities.

6.1 Location of Reclamation Facilities

Both augmented Alternative "B" (upstream/coastal treatment) and "E" (maximum reclamation) propose the construction of the Sepulveda Treatment Plant. This facility would provide hydraulic relief for the San Fernando Valley area by relieving the flow constriction in the existing tunnel through the mountains. The inland plant would also serve as a major potential source of reclaimed water for the San Fernando Valley. Under augmented Alternative "B", HTP would make reclaimed water available for industrial uses that may be developed in central and southern Los Angeles.

Alternative "E" attempts to maximize the chances for reclamation by reducing the extra cost to supply reclaimed water above that basic cost required for wastewater disposal. Alternative "E" in addition to proposing the Sepulveda plant, also proposes the construction of a La Cienega Water Reclamation Plant (LCWRP) at 75 mgd capacity upstream from the Hyperion Treatment Plant. This facility could make reclaimed water available for industrial water uses that may be developed in central and southern Los Angeles areas. It is assumed that this LCWRP would produce a filtered secondary effluent of a quality requiring only the addition of the biological nitrification process to be acceptable for many industrial reclaimed water markets (Addendum I).[7]

However, the City of Los Angeles does not presently own land in the vicinity of Culver City for the site of the proposed LCWRP.

> Site acquisition for the La Cienega Water Reclamation Plant is estimated to take at least five years, if it can be acquired at all. With a few years to resolve justification of the LCWRP, this would result in a delayed start-up date of 1983 at the earliest, and possibly much later if anticipated land acquisition problems develop (Addendum).[7]

6.2 Location of Industrial Users and the Potential Markets

The areas of highly concentrated industry and water use are in the El Segundo area, the Carson-Torrance area, the Los Angeles Harbor area, the Vernon-Commerce area, and some smaller localized areas in the San Fernando Valley. Most of these potential markets are outside the City of Los Angeles and presently receive their water supply from another water purveyor. Developing reclaimed water markets in those areas will involve additional problems that would not exist for markets within the City.

> Of these areas, surveys were conducted in El Segundo, Carson-Torrance, and Los Angeles Harbor, to determine potential reclaimed water use. Several specific uses were also identified in the San Fernando Valley. Due to time constraints, the Vernon-Commerce area has not been surveyed; potential reclaimed water use for this area was assumed from a list of large water users, supplied by the City of Vernon.[7]

According to surveys, the total industrial water use in the El Segundo and Carson-Torrance areas which could, theoretically, be supplied from a reclaimed water source is 55 mgd of which 9 mgd is in El Segundo and 46 mgd is in the Carson-Torrance area. In Addendum I, these figures are "used for comparison of wastewater disposal alternatives only and do not in any way constitute firm demands."[7]

A survey (1973) in the Harbor area indicated a potentially developable market of approximately 5 mgd for highly varied industrial uses, ranging from cooling tower makeup through oil-well pressurization to general shipyard use.[7]

No data are presently available for the potential markets of reclaimed water in the Vernon-Commerce area where there are widely varied uses of industrial water, including rubber and paper production, metal fabrication, glass, chemicals and others. In Addendum I, it was assumed that an industrial water use of 20 mgd could potentially be developed in this area.[7]

Although the San Fernando Valley has some potential for industrial water uses, these are quite small, widely scattered, and are probably not feasible to supply.[7] There are three fossil fuel power plants in the San Fernando Valley which utilize cooling towers; the Burbank Steam Plant, the Glendale Steam Plant, and the City of Los Angeles Valley Steam Plant. Reclaimed water is currently being supplied to the Burbank Steam Plant for cooling tower makeup from the Burbank Water Reclamation Plant. The other two plants could also use reclaimed water with a potential for using 3 mgd at the Glendale Steam Plant and 2 mgd at the Valley Steam Plant.[7] The proposed Sepulveda Plant could supply reclaimed water for the Valley Steam Plant, but the present anticipated end of the economic life of that steam plant is 1984, so unless the life of the plant is extended beyond 1984, the investment in pumps and pipelines to supply reclaimed water would not appear feasible.[12]

The information in Addendum I suggests that a potential exists to reclaim a maximum of 85 mgd of wastewater for industrial water supply purposes.

> However, these industrial uses exist in five separate areas of the City of Los Angeles and surrounding communities: El Segundo area, Carson-Torrance area, Los Angeles Harbor area, Vernon-Commerce area, and San Fernando Valley area.[7]

As noted previously, some of these uses may be difficult to develop due to administrative and cost problems.

The construction and operation of the proposed La Cienega facility is required for the maximum development of cost-effective industrial use of reclaimed water, but it is subject to lengthy delays because of siting and other constraints. The suggested temporary and interim solution (the advanced primary treatment concept at HTP)requires at least a limited study to determine whether it will work, and it would require special regulatory considerations and a change in the NPDES permit.

The determination of the actual demand requires additional surveys, coordination, and finally, commitments from individual industries. Any potential industrial markets in the eastern and southern Los Angeles area must take into consideration the competition for these markets between the City of Los Angeles and the sanitation Districts of Los Angeles County.

6.3 Industrial Water Quality Requirements

There are existing industrial uses of reclaimed water, especially for cooling towers, and from this experience there has developed a set of water quality criteria for such uses. In order to minimize the user's operating costs, Los Angeles must deliver a reclaimed water of a constant water quality. With this as a constant factor, then specific water quality criteria should be developed on a case basis through considerations that include the reclamation plant's advanced treatment options and respective costs, and the user's inplant treatment options and costs.[12]

Much of the proposed industrial use of reclaimed water in the Los Angeles area is for cooling purposes. This involves the use of recirculating cooling water systems rather than once-through systems. In this situation, certain water quality requirements must be met before industry will accept the use of reclaimed water.

Such water preferably should *not*:

- deposit scale
- corrode the cooling system
- encourage the growth of slime-forming organisms
- deteriorate wood in cooling towers (delignification)
- require excessive amounts of blowdown[7]

Some of the important water quality parameters which determine the usability of reclaimed water for cooling purposes include orthophosphate, ammonia, suspended solids, hardness, alkalinity, pH, and total dissolved solids.

Industrial water quality criteria typically sets a limiting concentration on phosphate as a means of controlling the scaling tendency of a makeup water. Scaling is usually caused by the deposition of calcium phosphate salts. Literature shows that the water quality criteria for cooling purposes typically limit the phosphate concentration to 1-2 mg/l. This very stringent requirement often dictates that most secondary effluent must be treated for phosphate removal via the use of lime, aluminum salts, or iron salts to insure that the water does not scale the heat exchanging surfaces and consequently cause loss of heat transfer efficiency.

A corrosive or aggressive water can also cause serious problems when used for cooling, in that the piping and equipment of the cooling system may become damaged. Organic materials in the water can lead to pitting and localized corrosion of metallic surfaces. Excessive concentrations of ammonia can corrode copper and copper alloys. Low pH waters are also very corrosive. Thus, a balance between scaling formation and corrosion must be reached for good operations.

The growth of microorganisms that may act as contributors to corrosion or as slime formers that foul the surfaces of cooling towers and piping is detrimental to operating efficiency. Control of suspended solids and proper disinfection usually eliminates these problems.

Delignification is mainly caused by the presence of sodium carbonate in the cooling water. It is recommended that the pH of cooling water be maintained between 6.5-7.5 for a more favorable carbonate-biocarbonate balance.

High total dissolved solids in the cooling water requires an increase in the amount of blowdown from the cooling tower. A recent Contra Costa Water District Study determined that, as a result of high TDS, increased blowdown was required, and consequently, more water was required for the same amount of cooling. In addition, greater wastes were produced which entailed higher waste treatment costs to the user. Thus, the lower the TDS concentration, the higher the number of concentration cycles that can be achieved. This results in lower water consumption and lower cost to the user.[7,12]

The development of cost-effective industrial reclamation projects would not be constrained by substantial public health issues for they do not involve the planned ingestion of reclaimed water. However, potential cross-connection problems do exist, thus plumbing codes and plant management practices would have to be adhered to strictly.

Water quality requirements for industrial use and associated costs have been addressed in Addendum I.

For a supply of reclaimed water to the Vernon-Commerce Industrial markets, the Whittier Narrows and San Jose Creek Water Renovation Plants of the L.A. County Sanitation District are possibly more conveniently located, but produce a water quality that is inferior to the City's Hyperion or proposed La Cienega facilities. In terms of having the best secondary City's Hyperion or La Cienega appears to have an advantage in terms of TDS on the County's Los Coyotes facility. This advantage assumes the Long Beach WRP effluent will be totally committed as it is presently. Note that the City's Terminal Island and the County's Joint Water Pollution Control Plant facilities' effluent have a poor water quality that appears to preclude the production of a cost-competitive reclaimed water.[12]

Thus, for the DWP to successfully develop reclaimed water to supply the Venon industrial market or the southwestern Los Angeles oil refineries, the DWP must develop a reclaimed water supply that is as reliable or more reliable than the alternative supply, of a quality that is suitable for the use, and priced competitively to assure that it would be financially attractive to the various industries. It should be noted that the competition between the City and County in supplying these reclaimed water markets does not preclude an approach whereby the City and the County could coordinate their reclamation planning to produce the most cost-effective reclaimed water supply for each particular use.[12]

6.4 Impact of Industrial Use on Discharge Requirements

A major constraint to the development of reclaimed water would be the impact of industry's use of reclaimed water on their current industrial discharge requirements. Wastewater collected and treated by the Department of Public Works and then reclaimed by DWP for industrial purposes would contain a certain amount of inorganic wastes. Industrial use would further concentrate this waste and change the point of discharge, although there would be no change in the total waste loading to the receiving water.

Under current regulations, the industry may be required to return its used reclaimed water to the wastewater plant for discharge, thus limiting its operational flexibility and increasing costs. Regulatory agencies would have to develop a procedure which would allow industry to reuse water and not be penalized for the amount of waste already in the water before any significant reuse activities are pursued.[12] This topic will be further analyzed for the final EIS.

6.5 Impact of Maximum Industrial Use on the Marine Environment

The survey of potential industrial users of reclaimed water showed that the La Cienega Water Reclamation Plant would be in a prime location to supply the potential market. The difficulties anticipated in obtaining land for the treatment plant would result in many years delay in implementing Alternative "E" over augmented "B". Such a delay in construction of LCWRP under sub-Alternative E1, but not E2, would include temporary installation of advanced primary treatment at HTP in order to allow full secondary treatment at Hyperion. However, it is not known whether this advanced primary treatment would in fact satisfy secondary quality requirements for the interim period until LCWRP is operational, and it would require at least a limited study to determine its feasibility. This temporary proposal would also require special regulatory consideration and a change in the NPDES permit. "Regulatory agencies have not shown a willingness to lower their discharge standards in the past."[7]

If full secondary treatment at HTP were delayed, there would be a continuation of adverse impacts on the marine environment as described in Chapter III of the EIS. (Sludge discharge to the ocean would be discontinued so that impacts would be only those attributable to the 5-mile outfall.) If 307 mgd of secondary treatment were installed at HTP and later reduced to 232 mgd, there would be a substantial capital cost as described in Chapter VII of the EIS for Alternative E2.

6.6 Potential Impacts on Land Use of Industrial Uses of Reclaimed Water

Material presented in Chapters II and IX of the EIS demonstrates that water supplies are not currently acting as a constraint to growth in the City of Los Angeles. Therefore, no major changes in land use patterns or anticipated growth would be expected as the result in increased amounts of water being available for other than industrial uses. An eventual change in the pattern of industrial development might result from the availability of reclaimed water at specific locations if the costs of water to industry were low. Addendum I has shown that a low price of reclaimed water to industrial consumers would require subsidies, but the degree of subsidy needed as compared to subsidies of the costs of water from other sources has not been examined. In the event that cheap water were available near water reclamation plants, water intensive industries might tend to locate in these areas. Important limiting factors include zoning (which presently is not compatible for locations near Sepulveda), and air quality regulations that would severely limit the types of industry permitted to locate in the South Coast Air Basin. At this time, it is unrealistic to predict any land use changes that might be induced by industrial uses of reclaimed water.

7. POTENTIAL SECONDARY IMPACTS OF RECLAIMED WATER AS AN IRRIGATION AND RECREATION WATER SUPPLY

Suggested uses of reclaimed water have included (1) the irrigation of parks, golf courses, cemetaries, and landscaping along freeways; (2) the creation of ornamental and recreational lakes; (3) the augmentation of stream flows; and (4) fire protection.

Although there are many small parks, golf courses, landfills, and cemetaries in the Los Angeles area, including the Santa Monica Mountains and the coastal plain, they offer a less likely market for reclaimed water for irrigation purposes. This is because such uses represent only small and variable demands, which, by themselves, may not be cost-effective. Such use would depend upon the existence of a nearby reclaimed water system such as an industrial supply line installed to serve the same area.

However, there are existing and proposed major park areas where a market for reclaimed water might be developed. The existing parks are Griffith Park and the Sepulveda Basin Recreation Area; the proposed park is the Baldwin Hills Regional Park. There is a possible small use of reclaimed water at Topanga State Park.

There are approximately 4,200 acres in Griffith Park, which is the largest single park development in the City of Los Angeles. A draft master plan (1974) for the park showed a maximum reclaimed water demand for general irrigation purposes of 8.3 mgd for the golf courses and picnic areas. The recreational use of reclaimed water would include a limited number of ponds and marshes. Lakes would be developed in the existing golf courses and in several of the park's canyons. Reclaimed water for fire fighting would be provided by a system of fire hydrants along all major existing roads supplied by reclaimed water. The estimated maximum potential for reclaimed water use in Griffith Park is 10 mgd. The majority of this hypothetical demand is based on new uses not currently being supplied.[7]

Reclaimed water for use in Griffith Park will be provided by the LAGWRP, and a pump station, transmission pipeline, and a 2 million gallon tank have been installed for this purpose. Studies are being made to convert the existing water system in the Wilson and Harding golf courses and Crystal Springs picnic area to a dual water system with irrigation from the reclaimed water system and domestic uses from a separate system.

The master plan for the development of recreational facilities in the 2,000-acre Sepulveda Flood Control Basin shows five golf courses, numerous picnic areas, a wildlife refuge, and other recreational areas. It is estimated that the ultimate irrigation and recreation water needs for both existing and proposed recreational facilities in the basin are approximately 9 mgd. The construction of these facilities is not dependent upon the availability of reclaimed water, but it would displace the use of "domestic" water currently supplied by DWP and paid for by the Department of Recreation and Parks.

There is a proposal to acquire and develop approximately 1,300 acres of land for park purposes in the Baldwin Hills area. The park development will occur as the present oil field becomes depleted and is phased out over a period of time. It is expected that the entire park will not be developed until at least 1995. No reliable estimates of the amount of water use can be made because of the present conceptual nature of the plans, but water use could range from 1 to 6 mgd. If reclaimed water is not available, domestic water (if available) would be supplied by either DWP or Culver City.

There are no existing plans for the development of Topanga State Park, consisting of about 7,000 acres in the Santa Monica Mountains, for it is assumed that much of this land will be kept in a natural state without irrigation. While the park may have a need for fire protection, this would not constitute a significant water demand, and no estimates of potential water use can be made at this time.[7]

One small use of reclaimed water, which could soon be implemented because of its proximity to the Hyperion Treatment Plant, is a proposed irrigation system for landscaping along Imperial Highway and Pershing Drive near the Los Angeles International Airport.

Another suggested use of reclaimed water is for recreational lakes in the Los Angeles River Flood Control Channel.

> Treated wastewater discharged into the river channel could be used from lakes behind collapsible rubber dams which would allow the passage of flood waters. Additional treatment facilities would have to be provided to maintain the water quality in the lakes. Although this use has merit from a recreational viewpoint. it would have to be fully evaluated before any commitment could be made to the use. The estimated demand for these lakes is 5 mgd. The availability of water would depend on the degree of reclamation implemented at upstream treatment plants. At this time, very little interest has been shown in this use, since the river flow through the industrial area of town for much of its length and the setting for a lake would not be very attractive.[7]

However, a recent study in the Boston area indicated that proximity to recreational water is the most important factor in determining its use,[15] and recreational lakes in the Los Angeles River Channel would be in proximity to a large population of potential users. This study showed that water quality appears to follow behind proximity, beach cleanliness, setting, and beach facilities in importance to site choice or attendance. Another interesting element in the study is the finding that perceived water quality does not seem to be related to actual water quality:

> Bacteria counts, nutrients, and so on are not perceived by human senses. Turbidity and color are perceived moderately well by recreationists, but with only a low degree of reliability. Reputations of beaches as being good or bad may be a much more important determinant of water quality perception than the actual quality of the water itself. This conclusion tends to undermine any causal links between recreation behavior and water quality.[15]

In light of the finding that proximity is the most important factor in determining use of recreational water, the study concludes that "the principal benefit, in terms of recreational usage, of water quality improvements in urban areas . . . would be to reopen beaches which are proximal to large population concentrations."[15]

In summary, there is a total maximum potential need for irrigation and recreational water of 28 mgd which would be supplied by reclaimed water. Of this potential, only 14 mgd is likely to be implemented at the two major parks, Griffith and Sepulveda Basin. "The remaining potential use is not likely to be implemented unless a larger reclaimed water system such as for industrial supply is constructed that can supply the smaller uses."[7]

Potential beneficial impacts of the uses suggested include improved aesthetics along freeways due to better vegetative growth acting as a screen, and expansion of recreational facilities intended for intensive use. An associated adverse impact might be the loss of natural habitat if semi-undisturbed areas were converted to recreational areas because of the availability of water.

8. SUMMARY AND CONCLUSIONS

This section summarizes the major potential secondary impacts of the various proposed uses of reclaimed water in the Los Angeles area.

8.1 Background Policy and Future Trends

There has been a recent and sudden shift in the emphasis in water policy from concerns focused predominantly on water quality to a realization of the necessity for water conservation, through wiser water management and through such measures as wastewater reclamation and reuse. This is reflected at federal, state, and local levels.

> In [the United States], a series of water shortages, water disasters, and water problems are leading us to reconsider policies we have always taken for granted. We are turning away from water development, which suggests increasing withdrawals from an unlimited supply, to water management, which stresses wiser use of a limited resource. We are beginning to distinguish human *needs* for water from human *desires* for water.[20]

The above statements by Charles Warren, the new Chairman of CEQ, reflect a necessary change of attitude and shift in policy at the federal level. Water quality is the essence of the Federal Water Pollution Control Act Amendments of 1972 and its implementing regulations promulgated by EPA. The Act's ultimate goal is to achieve the total eliminations of pollutant discharges by 1985. Funding is made available for the planning, construction and operation of treatment plants designed to upgrade the treatment of effluent to meet the new, more stringent standards. However, existing laws do not make grant funds as easily obtainable for constructing the distribution systems that are essential for the use of reclaimed water. In light of the new emphasis on water conservation it is expected that remedial legislation will be forthcoming to encourage wastewater reclamation and to protect existing water rights when such a right is reduced by the substitution of reclaimed water. The California State Water Resources Control Board is seeking such legislative changes.

The severe water shortages induced by the drought in California have forced temporary accommodations, transfers and adjustments of water supplies. This recognition statewide of the commonality of the limited water resource may force many interagency arrangements and joint ventures in the future.

The opportunities for such management of water resources are evident in the conjunctive use of underground basins for water storage, the injection of reclaimed water for salinity barriers, and the areawide planning of distribution of reclaimed water for industrial use. These are administrative problems that may be impacted by parochial concerns, city charter restrictions, and other constraints but there is encouragement to maneuver into these cooperative water management areas. This is seen in the California Supreme Court's suggestion of a "physical solution" to the water supply problems experienced between the Cities of Los Angeles, Glendale, and Burbank.[11]

8.2 City of Los Angeles Wastewater Facilities Plan's Alternatives for the Reclamation and Reuse of Wastewater

Appendix F of the City of Los Angeles Wastewater Facilities Plan (Addendum 1 to this EIS) outlines alternatives for the reclamation and reuse of wastewater. Through a screening process these alternatives were reduced basically to two choices, which have been designated as Alternatives "B" (upstream/coastal treatment) and "E" (maximum reclamation). Both alternatives envision the construction of the Sepulveda Water Reclamation Plant, but "E" differs in adding to the plan the construction of the La Cienega Water Reclamation Plant upstream from Hyperion to process 75 mgd. According to the studies in Appendix F[7] Alternative "E" would benefit wastewater reclamation by producing a better quality water at LCWRP and would provide it close to an area of a potential industrial market. The study[7] essentially concludes that for water reclamation the implementation of Alternative B without La Cienega would result in increased requirements for dollars, land, energy, and revenue support as compared to "E". For wastewater treatment without reclamation, however, Alternative "B" is less expensive and with reclamation (augmented Alternative "B"), would remain less expensive until the reuse market exceeds 50 mgd.

Alternative "E" is absolutely dependent upon the construction and operation of the proposed La Cienega Water Reclamation Plant in the vicinity of Culver City, but the City of Los Angeles does not own land at the proposed site. The area is presently in high intensity commercial use and with high value residential property surrounding it. Procurement would be difficult.[7]

8.3 Constraints on the Proposed Uses of Reclaimed Wastewater

The study embodied in Addendum I proposes that the reclaimed water from the City's treatment plants be used for (1) groundwater replenishment by spreading; (2) seawater intrusion barrier supply; (3) industrial water supply; and (4) irrigation and recreation water supply.

Initially, the study[7] estimated a total potential reclaimed water market up to 193 mgd (216,000 acre feet/year) but some prospective markets are too small to be served economically so the maximum study figure was reduced to 177 mgd (198,000 acre feet/year). This reduced estimate may still be overly optimistic for there are very severe constraints to many of the proposed uses. Potential health problems in particular, are so complex and so difficult to resolve that proposed uses of the reclaimed water that would affect aquifers which may be used as public water supplies may not be realized for decades, if ever. For this reason, many of the proposed uses appear optimistic. The problems associated with the major proposed uses of reclaimed wastewater by the City of Los Angeles are evaluated as follows:

8.3.1 PROBLEMS ASSOCIATED WITH GROUNDWATER REPLENISHMENT BY SPREADING. The basic method for developing a steady water supply is to store surplus water for subsequent use during dry periods. Surface flows that would otherwise escape unused are saved for eventual use, thus averaging out the wide precipitation variations inherent in California's climate. Conventionally, those flows are saved by constructing a dam that holds the surplus water in a surface reservoir, but the construction of dams is expensive and disruptive of natural environmental systems, and surface water storage reservoirs preempt the use of large areas of land, and there is considerable loss of evaporation in an arid climate.

Storage of surplus water in natural underground basins, on the other hand, avoids most of the expense, and nearly all of the environmental and land use dislocations of surface water storage. In addition, underground storage eliminates evaporation losses (except at the spreading grounds), and provides natural distribution and filtration of the stored water. However, underground storage does involve some penalties, such as loss of energy due to the need to pump stored water out of the underground basins, and degradation of the quality of stored water if the local groundwater is of lower quality.[18] Substitution of underground basins in place of surface reservoirs requires consideration of operational factors such as groundwater percolation and transmission rates, groundwater quality, existence of water spreading and extraction facilities, electric energy supplies, and water service requirements.

Underground basins receive water naturally from rain, floods, and percolation from overlying rivers and lakes. Underground storage is accomplished by an artificial recharge that involves spreading large amounts of surface water over porous surface areas. The water's weight and density force it to percolate through the underlying soil and into the underground basin. Groundwater is stored in minute spaces that exist around the small particles, such as sand and gravel, which constitute the subsurface structure. Vast numbers of those spaces exist within geological formations known as aquifers or underground basins that may cover several square miles to a depth of hundreds of feet and may hold enormous amounts of water. The "safe yield" of such an aquifer or basin is the maximum quantity of water that can be extracted from a groundwater basin each year without gradually lowering groundwater levels in a manner that will eventually deplete the basin's groundwater supply. Some California communities have developed groundwater basin management to the point where they have tripled the natural safe yield by storing native and imported flood waters in surface reservoirs for later percolation into the local underground basin.[18]

The City of Los Angeles has consciously used the underground basin of the San Fernando Valley as a storage reservoir by spreading water imported from Owens Valley. The City has also pumped water out of the basin for areas of Los Angeles that lie outside the San Fernando Valley. The amount of local precipitation that percolates into the basin each year is about 50,000 acre feet,[11] however, annual extractions by all of the overlying cities have exceeded 90,000 acre feet.[19]

The San Fernando Valley is now a major suburban and industrial area, with a total of about 1.3 million people. A little over a million of those people live in the Los Angeles portion of the Valley, while the remainder live in the Cities of Glendale, Burbank, and San Fernando. Eighty percent of the overlying area's total annual water use of 285,000 acre-feet occurs within the portion lying in the City of Los Angeles.[19] A total annual use of 250,000 acre-feet would be about five times the basin's safe yield based upon natural replenishment. Obviously most of the water used each year in the San Fernando Valley must be imported from other areas if the basin is to avoid a major annual overdraft of its groundwater supplies. The basin does have an enormous storage capacity, estimated at 500,000 acre-feet, so the possible use of reclaimed wastewater for basin recharge and storage is an attractive proposal.

In the past there have been legal uncertainties over the rights involved in the utilization of the underground storage space in the San Fernando Basin. These uncertainties concerned the rights (1) to store imported water underground, (2) to protect that water while it is stored, and (3) to recapture the stored water when it is needed. However, under the Supreme Court's ruling[11] of 1975 the City of Los Angeles is now free to store and extract imported water in the San Fernando Basin. Presently, the City has been spreading 1.5 cfs of natural runoff and Owens River water at the Tujunga spreading grounds and 10 cfs of runoff diverted from the Los Angeles River at the Headworks Spreading Grounds. The proposal by the City is to use a maximum of 70 cfs of reclaimed wastewater to recharge and replenish the San Fernando Basin. Of this amount 50 cfs would be extracted for domestic use and 20 cfs would be stored to replenish the basin. If this proposal is implemented it would reduce the projected need for MWD water in the year 2000 from 118 cfs to 68 cfs. This is approximately 32 mgd or 36,250 acre-feet/year of MWD water that would be available for other uses in Southern California. The allocation of this water would be determined by MWD policies at that time. There are many indirect effects that could potentially be induced by the availability of this amount of water to customers outside the City of Los Angeles, but in view of the strong water conservation policy being espoused by MWD it is unlikely that this water would have any significant growth-inducing effect.

There are clear benefits to the City of Los Angeles from the use of reclaimed wastewater to recharge the basin. Such use of reclaimed water includes, *inter alia,* the following benefits:

1. Reduces the need to purchase 50 cfs of more expensive MWD water.
2. Provides a cushion against the adverse impacts of drought-induced shortages.
3. Eliminates the pressure to construct new importation facilities that are expensive in dollars and energy.
4. Permits planned, stabilized uses and allocations of water by DWP based on a known and reliable supply.
5. Mitigates inter-regional, inter-basin conflicts on water use (north vs. south, Owens Valley agriculture vs. Los Angeles).
6. Paves way for more areawide cooperation and conjunctive use of the underground storage capacity.

Although these and other benefits are major reasons for the development of this use of reclaimed water there are serious restraints that impede its implementation. The major constraints relate to eventual human consumption of the reclaimed water. The Department of Health is concerned over the health hazards posed by stable organics and viruses that may be present in the reclaimed wastewater. No final reclamation criteria for such use of this water have been established, but some interim regulations have been drafted. These are designed to assure that the quality of the reclaimed water after treatment and soil percolation will meet the National Interim Primary Drinking Water Standards. These interim regulations are subject to modification, but presently require as minimum treatment, an adequately oxidized wastewater by conventional secondary treatment followed by carbon adsorption and percolation through an unsaturated zone of undisturbed soil for a minimum distance of 10 feet. The Department of Health excludes chlorination for disinfection and believes that safe water can be achieved by percolation through the soil and at least a year in transit to the nearest well, without the need for chemical disinfection.

A major constraint is the requirement that not more than 50 percent of the water entering the groundwater basin at a spreading area during any 12-month period may be reclaimed water. The City may have difficulty in meeting this requirement and if it cannot produce evidence that there is a minimum 50 percent dilution of reclaimed water at extraction from any point in the basin then this use of reclaimed water cannot proceed as proposed and a re-evaluation of costs would be necessary.

The difficulty of meeting the 50 percent dilution requirement is because such dilution at the spreading area is only possible during part of each year. During peak pumping periods (summer months) there is not adequate system capacity to provide water for dilution. It is possible that the natural recharge water entering the basin at many locations would sufficiently dilute the reclaimed water to meet the dilution requirements at extraction points, but the City has the burden to demonstrate this under the interim regulations of the Department of Health.

These health considerations, the construction of advanced treatment capacity at Sepulveda, and the matter of consumer acceptance of the changed blends of water are constraints that presently impact this proposed use of reclaimed water.

A 1975 report[17] indicates that 100 percent of the water spread at the Tujunga Spreading Grounds is assumed to be tributary to the North Hollywood Well Field. According to this report and assuming no carbon adsorption treatment of effluent, spreading 45 cfs of Sepulveda facility reclaimed water at Tujunga could result in a significantly lower water quality served to Los Angeles customers as compared to the current operation. However, primary drinking water standards would likely still be met. The degradation of water quality would result from the North Hollywood wells operation which would introduce the reclaimed water into the River Supply Conduit.

The 1975 report[17] also analyzed the situation which would result if the Headworks Spreading Ground were operating at its maximum of 35 cfs spread as follows:

> The percent reclaimed water, CCE, COD and TDS served to all the customers is directly related to the amount of water spread at Headworks Spreading Grounds (HSG). In general, the more water spread, the lower the water quality served to the customers. However, operation of HSG in the range of zero to 10 cfs does not appear to significantly influence the water quality served to Los Angeles or Glendale. With HSG shut down, the gross organics concentration is equal or lower than that which is currently served.[16]
>
> The L.A. Zoo and Glendale would receive the lowest water quality with HSG operating at its maximum of 35 cfs apread. Headworks Wells can intercept an amount of water spread at HSG that is equal to its maximum pumping rate of 24 cfs. With 35 cfs being spread at HSG, deep percolated water in excess of 24 cfs would flow past Headworks Wells and would be intercepted by Crystal Springs and Grandview Wells. This additional flow of water further lowers the water quality pumped by these two wells. The impact on the L.A. Zoo could be minimized by serving the zoo from the RSC rather than by its current tap off the Crystal Springs Wells.[17]

A different TDS result was reached by a 1976 study[12] also by the DWP which concluded that in terms of salinity (TDS) there would be no adverse impacts on groundwater quality from spreading Sepulveda reclaimed water at Tujunga.

8.3.2 PROBLEMS ASSOCIATED WITH USING RECLAIMED WASTEWATER AS A SEAWATER INTRUSION BARRIER SUPPLY. The West Coast Basin Project is a series of injection wells, supply pipelines, and other facilities located parallel to the coastline between Los Angeles International Airport on the north and Palos Verdes Hills on the south. Water supplied by the MWD is injected into the aquifer to create a freshwater pressure mound which prevents the flow of seawater into the aquifer. The increasing cost of MWD water led to the consideration of using reclaimed wastewater as a substitute barrier supply.

Demonstration studies to test the feasibility of using reclaimed water for this purpose are too expensive to be conducted at this time by the Central and West Basin Water Replenishment District. This excessive cost is attributed to (1) a significant expansion in the scope of studies to satisfy health concerns, (2) reductions in the anticipated amounts of grant funding, (3) equal sharing of the development costs between the Department of Water and Power and the Replenishment District, and (4) inflation.

Direct injection of reclaimed water into an aquifer used for domestic water supply requires more stringent health related criteria than any other reclaimed water use. This is because water quality limits must be met before injection since no substantial subsurface treatment is assured to occur. There is no slow percolation through the soil mantle as there is with groundwater replenishment by spreading. Reclaimed water used for injection must meet all mandatory drinking water standards and have a low organic content to insure safety from a health standpoint. Esthetically, it must be of a quality which does not cause the dissolving of soil minerals which may increase hardness, TDS, or iron or manganese content. In addition, the water must not exceed a maximum suspended solids concentration of 5 mg/l to minimize the rate of increase of the injection head pressure and be of a quality that will not tend to cause clogging and well-redevelopment.[7]

The barrier project will continue to be an expensive operation regardless of the water supply for it. Under present constraints the use of reclaimed water is indefinitely delayed.

8.3.3 PROBLEMS ASSOCIATED WITH RECLAIMED WATER FOR USE AS AN INDUSTRIAL WATER SUPPLY. There are several deterrent factors to the possibility of the City of Los Angeles serving reclaimed water to industry. These include the following:

1. Many of the potential uses could be served as readily from treatment plants of the County Sanitation Districts of Los Angeles County, which, however, has lower quality water.
2. The construction and operation of the proposed La Cienega Water Reclamation Plant with a 75 mgd capacity to produce reliable, high quality water is fundamental to the implementation of Alternative "E", but there are major siting and land acquisition problems involved that will be difficult to resolve.

3. The cost to industry of installing a dual water distribution system to segregate the potable water from the reclaimed water supply. This cost, along with those for other necessary modifications, are included as penalty costs to industry for the use of reclaimed water.[7]

4. The problem of discharge of industrial wastes to receiving waters must be resolved for the salts that have been concentrated during use would exceed discharge requirements. This problem with state regulations must be resolved before any significant reclamation for industrial use is implemented.

8.3.4 PROBLEMS ASSOCIATED WITH THE USE OF RECLAIMED WASTEWATER FOR IRRIGATION AND RECREATION WATER SUPPLY. Reclaimed water used for spray irrigation and non-restricted recreational impoundment is required to be an adequately disinfected, oxidized, coagulated, clarified, filtered wastewater. The major constraint is the necessary construction of dual water systems to separate the potable water at parks and golf courses from the reclaimed water system.

There are guidelines for acceptable water quality for irrigation in terms of the effect of chemical constituents on plant physiology. It is not definitely known what the long term effect of the use of the reclaimed water would have on the varied vegetation in Griffith Park and the Sepulveda Basin Recreation Area.

The constraints on the use of reclaimed water for irrigation are more easily resolved than those for the other proposed uses of groundwater recharge, salinity intrusion barrier, and industrial supply, so it is estimated that both Griffith Park and the Sepulveda Basin will be using reclaimed water in 1981.

In Addendum I the projected use of such irrigation water is estimated as 14 mgd with Griffith Park receiving 5 mgd and Sepulveda Basin Recreation Area using 9 mgd. The Griffith Park system is now being developed to be supplied by LAGWRP, and the Sepulveda Basin is to be supplied from the proposed Sepulveda Treatment Plant. This water will be purchased by the Los Angeles City Department of Recreation and Parks.

An additional estimate of potential uses of reclaimed water for irrigation and recreation in Appendix F[7] includes a total of 14 mgd of water for the proposed Baldwin Hills Regional Park, Topanga State Park, cemetaries, freeway landscape, and Los Angeles River lakes. These uses are in the conceptual planning stage or require the existence of a nearby large industrial water system as a source of supply. Accordingly, these are not included in the total 177 mgd estimated for uses of reclaimed water in all the water service areas identified in Appendix F.[7]

REFERENCES

[1] Policy and Action Plan for Water Reclamation in California. (Draft) California State Water Resources Control Board, December 1976.

[2] Planning for Wastewater Reclamation. Planning Program Guidance Memorandum. State Water Resources Control Board. Office of Planning, Water Quality Control Planning Program. 1 January 1977. 3 pp.

[3] Statement by the Metropolitan Water District of Southern California on Draft EIR/S for the Joint Outfall System Facilities Plan of the Sanitation Districts of Los Angeles County. Presented at public hearing in South Gate on 20 May 1976, by Donald C. Brooks, Director of Planning, Metropolitan Water District.

[4] Proposed Revision to Clean Water Grant Program Regulations (in Policy and Action Plan for Water Reclamation, footnote[1]).

[5] California Adm. Code. Title 22, Chapter 4, Section 60301, *et seq.*

[6] A "State-of-the-Art" Review of Health Aspects of Wastewater Reclamation for Groundwater Recharge. State Water Resources Control Board, Department of Water Resources, Department of Health, September 1975.

[7] The Effect of the City of Los Angeles Wastewater Management Plans on Potential Water Reclamation. Appendix F to City of Los Angeles Wastewater Facilities Plan. Prepared by City of Los Angeles Department of Water and Power, Water System - Sanitary Engineering Division. SED Rept. 77-21. March 1977.

[8] EPA Regulations on Preparation of Environmental Impact Statements, 40 CFR 6.304.

[9] Council on Environmental Quality Guidelines on Preparation of Environmental Impact Statements, 40 CFR 1500.8.

[10] In the case of *City of Los Angeles v. City of Glendale* (1943) 23 Cal. 2d 68, [142 P. 2d 289] it was stipulated in October 1939 between the City of Los Angeles and the defendants, Glendale and Burbank, that 27.5 percent of the Owens water used for irrigation in the San Fernando Valley "has entered and is now entering" the valley's underground supply.

[11] *City of Los Angeles v. City of San Fernando* (1975) 14 Cal. 3d 199 [537 P. 2d 1250].

[12] The Value of Water Reclamation to a Wastewater Management Plan. Prepared by City of Los Angeles Department of Water and Power, Sanitary Engineering Division. SED Report No. 76-12. April 1976.

[13] "Compromise Ordered on Owens Valley Water." Los Angeles Times, Tuesday, 26 April 1977.

[14] "High Court Asked to Settle Water Case." Los Angeles Times, 30 April 1977.

[15] The Recreation Benefits of Water Quality Improvements: Analysis of Day Trips in an Urban Setting. June 1976. Report prepared for EPA by Urban Systems Research and Engineering, Inc., Cambridge, Massachusetts. NTIS PB-257719.

[16] "No Oasis Ahead," Editorial, Sunday Edition, Los Angeles Times, 15 May 1977.

[17] The Effect of Sepulveda and Los Angeles-Glendale Water Reclamation Plants on Domestic Water Quality. Report 75-9, City of Los Angeles, DWP, Sanitary Engineering Division, December 1975.

[18] Gleason, V.E., 1976. Water Projects Go Underground. Ecol. Law. Quart. 5(4):625-668.

[19] Watermaster Service in the Upper Los Angeles River Area, California Department of Water Resources. Bull. No. 181-74, 1975 (cited in Reference 18).

[20] Address by Charles Warren, Chairman Council on Environmental Quality, 15 March 1977, U.N. Conference on Water, Mar del Plata, Argentina.

[21] Analysis of Municipal Wastewater Reuse (Technical Supplement to Orange County Facilities Plan and EIS).

[22] Auer, Jean (1977). State Policy Developments in Water Reclamation. Cal. Agr. 31 (5):8-9

[23] Ayers, R.S. and R.L. Branson (1975). Water quality guidelines for interpretation of water quality for agriculture. Univ. of Calif. Coop. Extension, Jan. 15, 1975. 13 pp. mimeo.

[24] Chang, A.C. and A.L. Page (1977). Trace elements in wastewater. Cal. Agr. 31 (5):32-33.

[25] Ayers, R.S. and R.L. Branson (1977). U.C. Guidelines for interpretation of Agricultural Water Quality. Cal. Agr. 31(5):25.

[26] Robinson, F.E., W.F. Lehman, and K.S. Mayberry (1977). Saltier Irrigation. Cal. Agr. 31(5):14.

[27] Wildman, W.E., R.L. Branson, J.M. Rible, and W.E. Cawelti (1977). Irrigation trial with Morro Bay Wastewater. Cal. Agr. 31(5):36-37.

[28] Harwood, L.M. (1977). Irrigating with Wastewater in Sonoma County. Cal. Agr. 31(5):37-38.

[29] Roberts, E.B., and R.M. Hagan (1977). Can Irrigation with Municipal Wastewater Conserve Energy? Cal. Agr. 31(5):45.

[30] EPA, December 1975. National Interim Primary Drinking Water Regulations (40 CFR 141). 40 FR 59565, December 24, 1975.

[31] EPA, July 1976. National Interim Primary Drinking Water Regulations (40 CFR 141). 41 FR 28402, July 9, 1976.

[32] EPA, March 1977. Proposed Secondary Drinking Water Regulations (40 CFR 143). 42 FR 17143, March 31, 1977.

[33] National Academy of Sciences, 1977. "Drinking Water and Health", 42 FR 132:35774, July 11, 1977.

[34] Environmental Reporter, 1975. "Current Developments", Vol. 6 (23), October 3, 1975.